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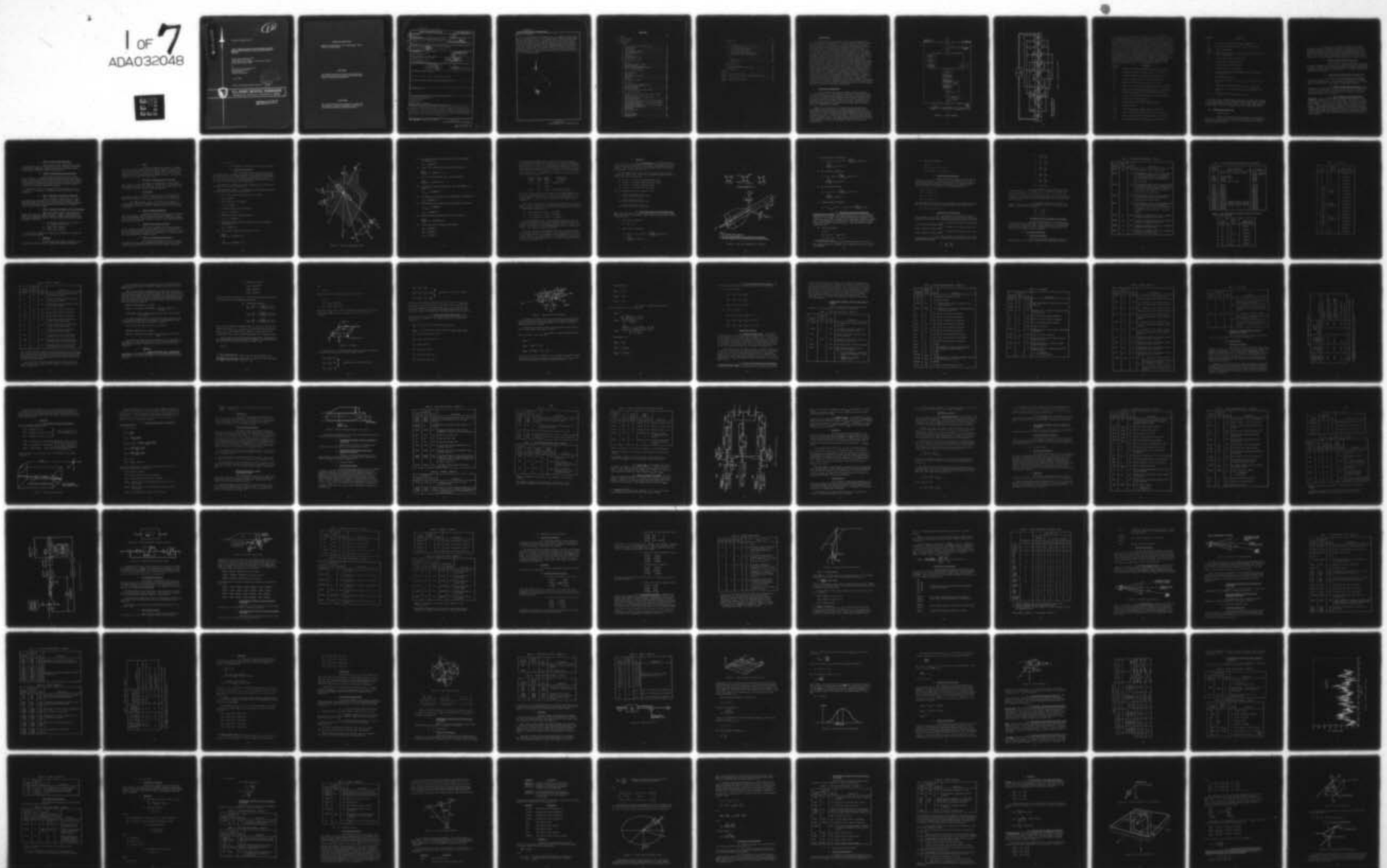

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TECHNICAL REPORT RG-7T-2

THAD T-7 MSSSILE MONTE CARLO TERMINAL HOMING SIMULATION UTILIZING ALS, DIGITAL/LINEAR AND TV SEEKERS

Charles L. Lewis and William R. Hooker
Guidance and Control Directorate
US Army Missile Research, Development and Engineering Laboratory
Redstone Arsenal, Alabama 35809

and

Abner W. Lee, Jr., and Jay Scott Harrison
Computer Sciences Corporation
515 Sparkman Drive
Huntsville, Alabama 35807

1 JULY 1976

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U.S. ARMY MISSILE COMMAND

Redstone Arsenal, Alabama 35809

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The all-digital, Monte Carlo six degree of freedom simulation program documented in this report provides a realistic method for the evaluation and analysis of a terminal homing weapons system. Included is a functional overview of the program, a detailed description of the individual modules and subroutines, a brief description (where appropriate) of the components modeled, and a guide to the use of the program. over

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The missile modeled in the program is the 7-in. HORNET airframe utilized as the basic flight test bed by the US Army Missile Command's Terminal Homing Accuracy Demonstration group. Two gimballed seekers are modeled which null on the line-of-sight vector to provide an initial signal for proportional navigation guidance. Either model, one simulating a four-quadrant (laser) seeker (with digital and digital/linear signal processing logic options), and the other simulating a vidicon (optical contrast) seeker, can be optionally selected. Another input option permits simulation of either a direct fire (prelaunch target acquisition) mode, or an indirect fire (target acquisition after launch) mode. A number of print and plot output options provide versatility of data presentation.

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I. INTRODUCTION

The all-digital, Monte Carlo six degree of freedom (6 DOF) simulation program documented in this report provides a realistic method for the evaluation and analysis of a terminal homing weapons system. Missile hardware components, vehicle dynamics, environment descriptions, and target motion are simulated by identifiable program modules. In some cases (e.g., the actuator and autopilot modules), both high and low frequency models are available, allowing simulations to be tailored to user needs. The missile modeled in the program is the 7-in. HORNET airframe [1] utilized as the basic flight testbed by the US Army Missile Command's (MICOM's) Terminal Homing Accuracy Demonstration (THAD) group. Two gimballed seekers are modeled which null on the line-of-sight vector to provide an initial signal for proportional navigation guidance. Either model, one simulating a four-quadrant (laser) seeker (with digital and digital/linear signal processing logic options), and the other simulating a vidicon (optical contrast) seeker, can be optionally selected. Another input option permits simulation of either a direct fire (prelaunch target acquisition) mode, or an indirect fire (target acquisition after launch) mode. Preacquisition guidance during an indirect fire mode simulation is provided by a preprogrammed trajectory, where trajectory shaping can be accomplished by an input parameter. A number of print and plot output options provide versatility of data presentation. A Monte Carlo approach was developed for generating circular error probability (CEP) related information. This report presents a functional overview of the program, a detailed description of the individual modules and subroutines, a brief description (where appropriate) of the components modeled, and a guide to the use of the program.

II. FUNCTIONAL DESCRIPTION

The 6 DOF Monte Carlo Terminal Homing Simulation Program, shown in Figures 1 and 2, provides the capability of simulating flights of a THAD T-7 terminal homing seeker-missile under varying input conditions. The operation of the stochastic 6 DOF program is automatic when all initial conditions and time series error source distributions are specified along with the number of runs to be made. In the absence of Monte Carlo data inputs, the operation of the 6 DOF program reverts to that of the deterministic version.

Figure 1 is a flow chart of the executive control subroutines. This figure gives an overview of the basic program operation that is independent of hardware modeling and flight simulation. Control of the events shown in each of the blocks is accomplished primarily through use of input data read in on special card types. These card types are identified by numbers from 1 to 10. Section IV.A contains detailed explanations of each card type. A detailed description of Figure 1, along with an explanation of program flow relating to card type, is given in Section III.A.

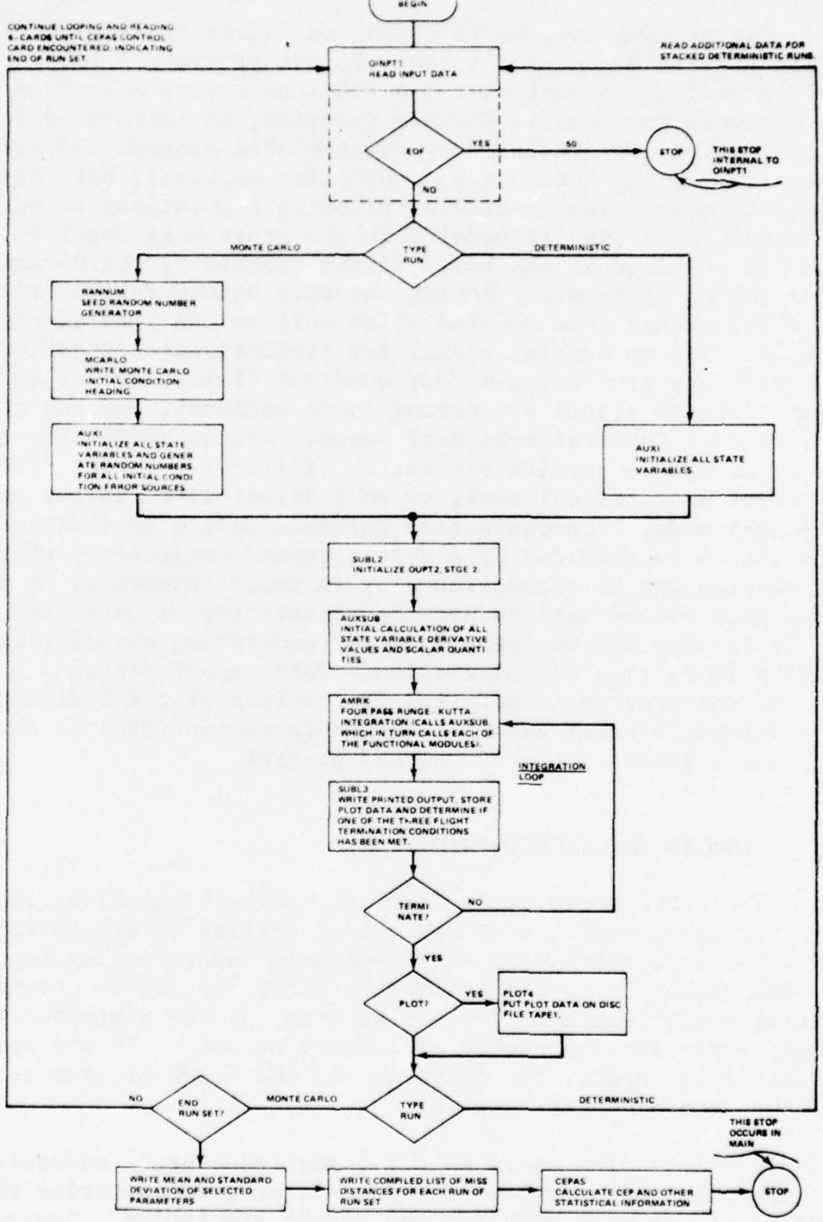


Figure 1. 6 DOF flowchart.

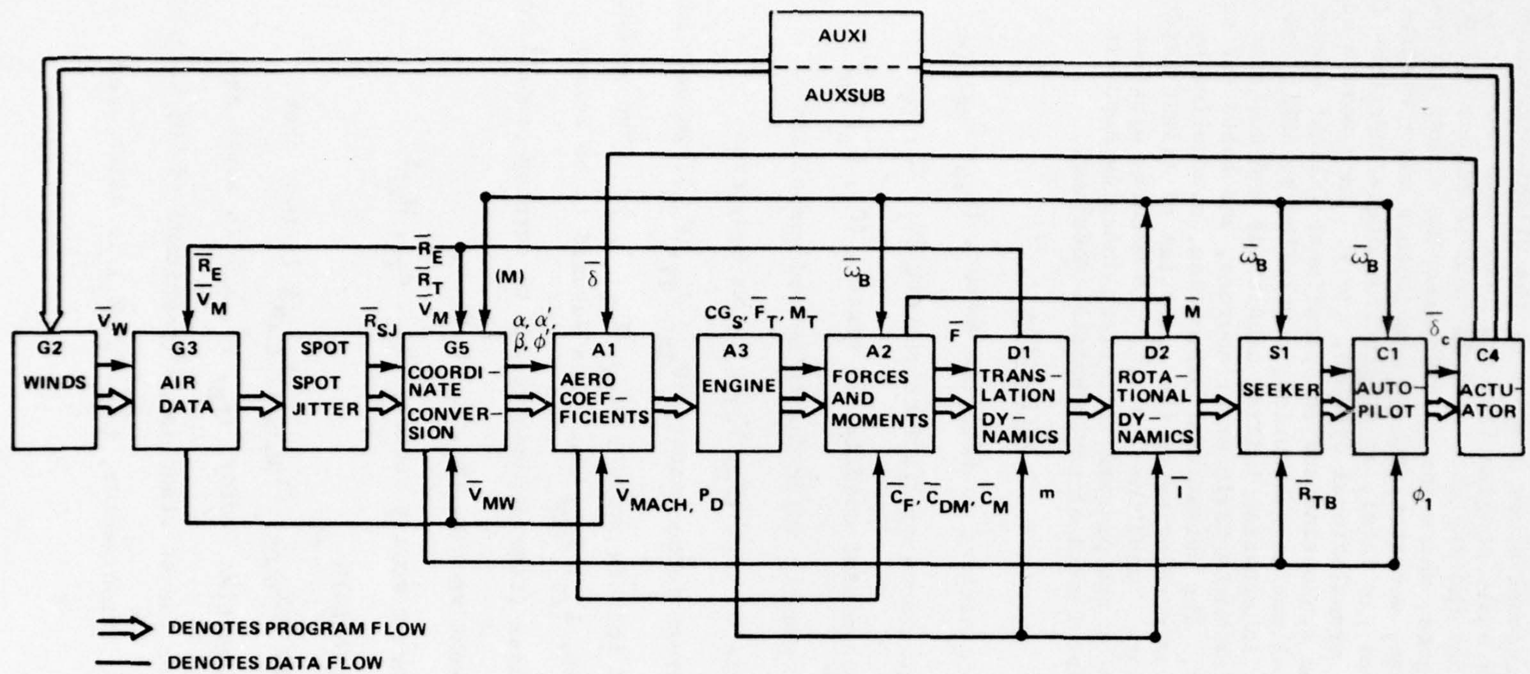


Figure 2. Modular block diagram.

Figure 2 is a functional block diagram of the flight simulation modules, depicting both basic program flow and basic data flow. A listing follows which defines the variable symbols used in Figure 2. The program is modularly designed, where the modules describe either hardware components (e.g., seeker, actuator, etc.), homogeneous environmental conditions (e.g., winds and air data), or simulation-unique functions (e.g., coordinate conversion, translational dynamic, etc.). Each module is made up of an initialization subroutine and an operational (flight execution) subroutine. The initialization subroutine, controlled by AUXI, calculates module constants, sets integration initial conditions and decision flags, draws random numbers for Monte Carlo error sources, and loads the numerical integration array. The operational subroutine, controlled by AUXSUB, contains all logic relating to the operation of flight hardware, time varying environmental conditions, etc. This modular approach facilitates adaptation of the program to reflect changing hardware components and different levels of environmental modeling.

Variable	Definition
$\overline{C}_{DM}$	Aerodynamic damping coefficient vector, $(C_{\ell p}, C_{mq}, C_{mr})$
$\overline{C}_F$	Aerodynamic force coefficient vector, (C_X, C_Y, C_Z)
$\overline{C}_M$	Aerodynamic moment coefficient vector, (C_ℓ, C_m, C_n)
CG_s	Center of gravity shift due to burned propellant
$\overline{F}$	Total force vector, (F_X, F_Y, F_Z), in body axes
$\overline{F}_T$	Engine thrust force vector, (F_{TX}, F_{TY}, F_{TZ}), in body axes
$\overline{I}$	Moment of inertia vector, (I_{XX}, I_{YY}, I_{ZZ}). (The products of inertia, I_{XY}, I_{XZ}, etc., are assumed to be zero.)
m	Vehicle mass (time dependent, due to burning propellant)
$\overline{M}$	Total moment vector, (M_X, M_Y, M_Z)
$\overline{M}_T$	Engine thrust moment vector, (M_{TX}, M_{TY}, M_{TZ})
P_D	Dynamic pressure
$\overline{R}_{TB}$	LOS vector $(\Delta X_{BLOS}, \Delta Y_{BLOS}, \Delta Z_{BLOS})$ in body axes
$\overline{R}_E$	Missile position vector, (X_E, Y_E, Z_E) in earth axes
R_S	Missile to target slant range (magnitude of LOS vector)
$\overline{R}_T$	Target position vector, (X_T, Y_T, Z_T) in earth axes

Variable	Definition
$\bar{R}_{\nabla}$	LOS vector, $(\Delta X_{LOS}, \Delta Y_{LOS}, \Delta Z_{LOS})$ in earth axes
$\bar{V}_M$	Missile velocity vector, (V_X, V_Y, V_Z), in earth axes
V_{MACH}	Missile Mach number
$\bar{V}_{MW}$	Missile velocity vector, (V_{WX}, V_{WY}, V_{WZ}), relative to the wind, in earth axes
$\bar{V}_W$	Wind velocity vector in earth axes
α	Missile angle of attack (pitch)
β	Missile angle of attack (yaw)
α'	Missile angle of attack (total)
Φ_1	Euler roll angle measured between missile attitude gyro and body axes
Φ'	Aerodynamic roll angle
$\bar{\delta}$	Fin position vector, $(\delta_1, \delta_2, \delta_3, \delta_4)$, for fins 1, 2, 3, and 4
$\bar{\delta}c$	Commanded fin position vector, $(\delta_{c1}, \delta_{c2}, \delta_{c3}, \delta_{c4})$
$\bar{\omega}_{\lambda}$	Pitch and yaw rate command $(\omega_{\lambda Q}, \omega_{\lambda R})$ to autopilot from seeker
$\bar{\omega}_B$	Body angular rate vector, $(\omega_P, \omega_Q, \omega_R)$

The Monte Carlo approach takes advantage of the dual mode operation of the 6 DOF program. The initialization modules call MCARLO to randomize all initial condition error sources. Then in the flight execution module, MCARLO is called to generate time series random conditions.

III. SUBROUTINE DESCRIPTION

A. MAIN Program

MAIN is the primary executive routine of the simulation program. All subroutines and modules executed during a simulation run are either called from MAIN, or are called by subroutines or modules which are called by MAIN.

Figure 1 is a flow chart of MAIN. This figure illustrates executive subroutine flow that is independent of hardware modeling and flight simulation. Control of the events in each of the blocks is accomplished primarily through use of input data read in on special card types. These card types are identified by numbers ranging from 1 to 10. A detailed description of each card type is given in Section IV.A. The following will relate card type to program operation.

a. OINPT1 - Data Card Input Subroutine

This subroutine reads all input data and sorts the cards according to card type. If an end-of-file (EOF) is encountered in OINPT1, execution will be terminated. When a 6-card is encountered, OINPT1 stops reading data and control passes to the decision point shown immediately below OINPT1.

b. TYPE OF RUN - Deterministic or Monte Carlo

The type of run is dictated by the presence or absence of type 8-cards. If no 8-cards are encountered by OINPT1, the run is deterministic. If 8-cards are encountered, the run is Monte Carlo. (8-cards contain input data for random error sources.)

(1) RANNUM - Random Number Generator. This subroutine is called only if the run type is Monte Carlo. RANNUM seeds the random number sequence for the Monte Carlo run set. The seed is input by 3-card and must be an odd octal whole number. (Monte Carlo inputs are given in Section III.C.7).

(2) AUXI - Module Initialization Control Subroutine. This subroutine calls the modules shown in Figure 2 to initialize integrators and set decision flags. For Monte Carlo runs, random numbers are drawn for each of the error sources that are modeled in the modules. (A description of error sources is given in Section III.C). The program flow shown in Figure 2 is not hardwired into the program. The calling sequence is specified by 2-cards that are input through OINPT1; thus, any sequence may be used. However, the sequence shown is recommended due to the natural flow of the program and to the fact that some modules may initialize quantities that are required by other modules.

c. <u>SUBL2 - Output Staging Subroutine</u>

This subroutine calls OUPT2, STEG2, and other executive subroutines as specified by 1-cards. Normally, only OUPT2 and STEGE2 are specified. STGE2 initializes some executive control flags. OUPT2 initializes print and plot arrays.

d. <u>AUXSUB - Operational Control Subroutine</u>

This subroutine calls each of the modules shown in Figure 2. (AUXSUB calls the operational subroutine of each module, while AUXI calls the initialization subroutine of each module.) The operational subroutines are called to make the initial calculation of all state vector derivative values and scalar parameter values to initialize the numerical integration sequence.

As stated in b.(2), the program flow shown in Figure 2 is not hardwired into the program. AUXSUB calls the modules based on 2-card input data.

e. <u>AMRK - Runge-Kutta Integration Subroutine</u>

AMRK calls AUXSUB. AUXSUB then calls each of the operational subroutines of the modules shown in Figure 2. AMRK maintains control while making the four Runge-Kutta integration passes. When four passes have been completed (this completes an integration step), control passes to SUBL3.

f. <u>SUBL3 - Output and Termination Control Subroutine</u>

SUBL3 calls OUPT3 to write output specified by 4-card and to store plot data specified by 7-card. Then SUBL3 calls STGE3, the integration control subroutine. STGE3 monitors flight time and flight termination switches. There are three conditions for flight termination. They are:

1) Ground impact (checked only if range to go is greater than 500 ft).
2) Target plane intercept.
3) Flight time exceeded.

The first two termination conditions are checked by G4, while the third is checked by STGE3.

g. <u>TERMINATE</u>

If none of the three flight termination conditions are met, control returns to AMRK and integration continues.

h. PLOT

Plotting is specified by 7-card. If 7-cards were input through OINPT1, then PLOT4 will be called at the end of each flight to store plot data on disc file TAPE1. TAPE1 is treated as an output file and must be disposed of at the end of the job to a remote terminal that has a Houston Instrument COMPLOT plotter. Section III.G.3 explains how to dispose of the plot file.

i. TYPE RUN - Deterministic or Monte Carlo

If the run is deterministic, control passes back to OINPT1. OINPT1 reads data for the next case. If no data cards are present, execution will terminate. If the run is Monte Carlo, control passes to the next decision point, END RUN SET.

j. END RUN SET

The end of the run set is indicated when the decision flag LSTEP is set to 11. LSTEP is set to 11 in OINPT1 when OINPT1 reads a 9-card. (A CEP control card must follow the 9-card.)

The number of runs in a set is dictated by the number of 6-cards input. Each 6-card generates one run. The end of the run set is indicated by placing a 9-card and a CEP control card in front of the last 6-card.

k. MEAN AND STANDARD DEVIATION

The mean and standard deviation of any parameter in the C-array may be calculated by specifying the parameter on a 10-card. The parameter value is sampled at the end of each flight (target impact), then the mean and standard deviation are calculated and printed at the end of the run set.

l. COMPILED LIST OF MISS DISTANCES

The Y and Z components and absolute magnitude of miss distance are compiled and printed at the end of each run set. The miss distances given in this list are then used to calculate a missile CEP. The miss distance components are referenced to the flight coordinate system described in Section II.C.10.

m. CEPAS - CEP Calculation Subroutine

The miss distance components (Y, Z) are saved from each run. Then a CEP, confidence intervals, and other statistical information are calculated from the set of miss distance components.

B. Modules

1. A1-Aerodynamic Coefficient Table Look-Up Subroutine

a. Functional Description

This subroutine utilizes the executive subroutines TABLE, TABL2, and TABL3 to retrieve the aerodynamic coefficients from data arrays stored in BLOCK DATA B. These aerodynamic coefficients are referenced to the wind axes coordinate system shown in Figure 3. For this coordinate system, a normal and axial force convention is used as opposed to a lift and drag force convention.

The independent variable arrays (Mach number, angle of attack, and fin setting) are stored in BLOCK DATA A.

The aerodynamic coefficient components and the independent variables of which they are a function are as follows:

1) Axial force coefficient at zero angle of attack -

$$C_{X0} = f_1(\text{MACH}) \quad .$$

2) Axial force trim coefficient -

$$\Delta C_X = f_1(\text{MACH},\alpha') \quad .$$

3) Untrimmed normal force coefficient -

$$C_{N'(\alpha')} = f_1(\text{MACH},\alpha') \quad .$$

4) Untrimmed pitching moment coefficient -

$$C_{m'(\alpha')} = f_2(\text{MACH},\alpha') \quad .$$

5) Incremental pitching moment coefficient due to aerodynamic roll angle (Φ') -

$$\Delta C_{m'} = f_3(\text{MACH},\alpha') \quad .$$

6) Pitch control moment coefficient due to fins -

$$\left(\frac{C_{m'}}{\delta q}\right)_{\Phi'=0} = f_4(\text{MACH},\alpha',\delta q)$$

$$\frac{C_{m'}}{\delta r}_{\Phi'=0} = f_4(\text{MACH},\alpha',\delta r) \quad .$$

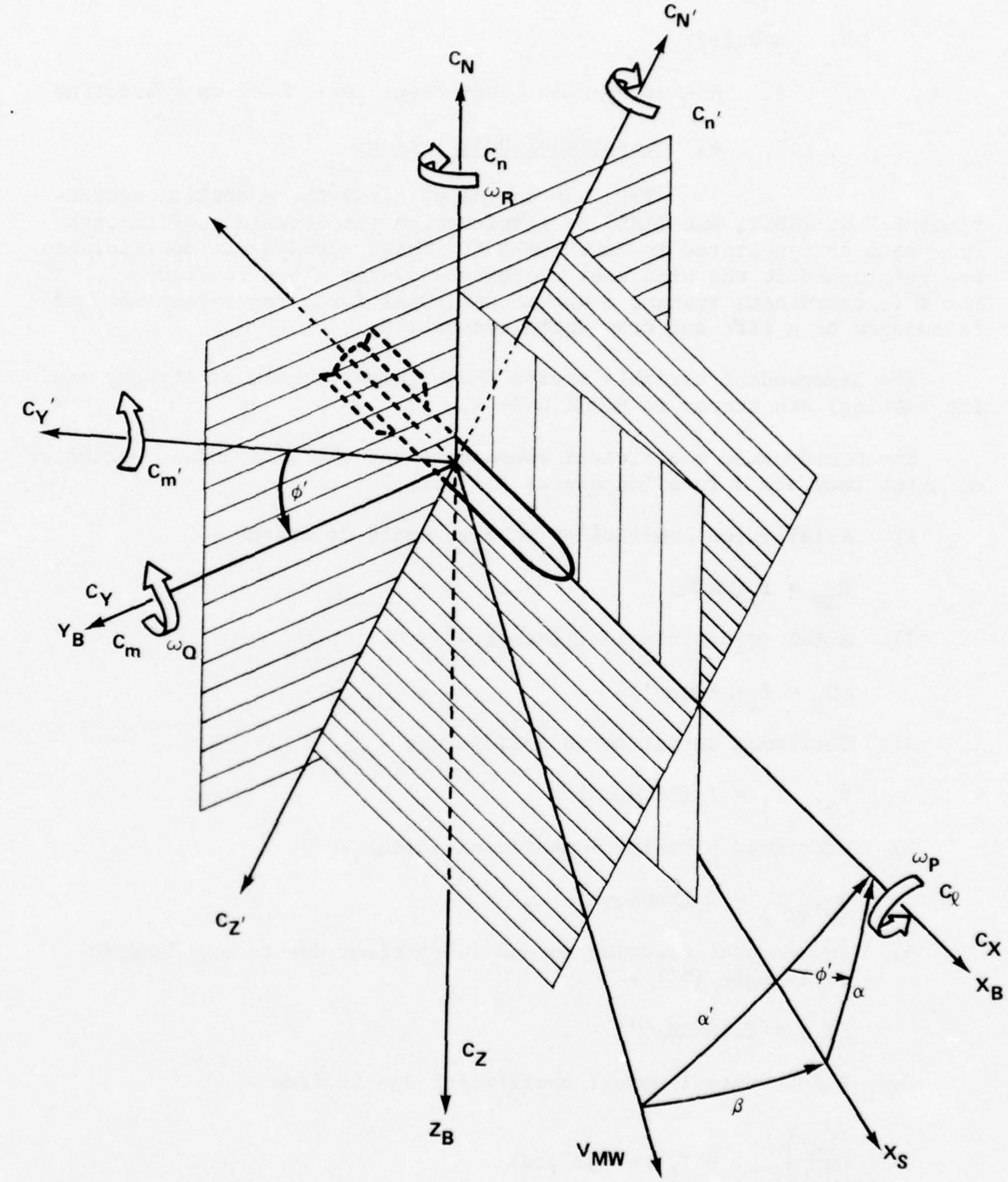


Figure 3. Wind axes coordinate system.

7) Incremental normal force coefficient due to aerodynamic roll angle (Φ') -

$$\triangle C_{N'} = f_5(\text{MACH},\alpha') \quad .$$

8) Normal force coefficient due to fin pitch position -

$$\left(\frac{C_{N'}}{\delta q}\right)_{\Phi'=0} = f_6(\text{MACH},\alpha',\delta q) \quad .$$

9) Normal force coefficient due to fin yaw position -

$$\left(\frac{C_{N'}}{\delta r}\right)_{\Phi'=0} = f_6(\text{MACH},\alpha',\delta r) \quad .$$

10) Incremental side force coefficient due to aerodynamic roll angle (Φ') -

$$\triangle C_{Y'_{(\Phi')}} = f_7(\text{MACH},\alpha') \quad .$$

11) Incremental yawing moment due to aerodynamic roll angle (Φ') -

$$\triangle C_{n'} = f_8(\text{MACH},\alpha') \quad .$$

12) Incremental rolling moment due to aerodynamic roll angle -

$$\triangle C_{\ell'_{\text{Lugs}}} = f_9(\text{MACH},\alpha')$$

$$\triangle C_{\ell'} = f_{10}(\text{MACH},\alpha') \quad .$$

13) Rolling moment coefficient due to fin roll control -

$$\left(\frac{C_{\ell'}}{\delta p}\right)_{\Phi'=0} = f_{11}(\text{MACH},\alpha,\delta p)$$

14) Pitch, yaw, and roll damping coefficients -

$$C_{mq} = f_{12}(\text{MACH},\alpha)$$

$$C_{nr} = f_{12}(\text{MACH},\alpha)$$

$$C_{\ell p} = f_{13}(\text{MACH},\alpha) \quad .$$

The independent variables and the dependent variables previously listed are stored in BLOCK DATA A and B and each dependent independent variable array is assigned to a COMMON BLOCK in their respective BLOCK DATA routines. When more than one independent variable is involved, the arrays containing the independent variables are located in a single COMMON BLOCK. For example, $C_{m'}(\alpha')$ is a function of two independent variables, MACH and α'. COMMON BLOCK assignments are made according to the following data listing:

Variable Name	Array Name	COMMON BLOCK	COMMON BLOCK Order
$C_{m'}(\alpha')$	CM	CMFUN	/CMFUN/CM (24)
α'	ALP1	CZARG	
MACH	AM1	CZARG	/CZARG/ALP1(6), AM1(4) .

The order in which the array name appears in the COMMON BLOCK is based upon which independent variable is held constant while the other is varied through its numerical range. The array name appearing first in a COMMON BLOCK is varied through its range while the second is held constant.

The instantaneous value of a coefficient is obtained from the data arrays by use of the executive subroutines (look-up subroutines) TABLE, TABL2, and TABL3. The look-up subroutines used depends upon the number of independent variables, e.g.:

1) One independent variable - use TABLE.
2) Two independent variables - use TABL2.
3) Three independent variables - use TABL3.

The instantaneous value of the independent variable is sent into the appropriate look-up subroutine, along with the COMMON BLOCK's containing the dependent and independent variable arrays. A linear interpolation is performed between appropriate points and the instantaneous value of the dependent variable is returned.

The force and moment coefficients of the control surfaces (fins) are given as a function of the ratio of the control surface coefficient to the average value of the combined angular displacement of the four control surfaces. The average value of the combined fin settings are computed in this module based upon the individual fin settings computed in the actuator module, C4.

b. Equations

(1) Fin Deflections. The average value of the combined fin settings based on individual fin settings are computed following the sign convention and fin setting configurations given in Figure 4. This figure illustrates the combined settings that produce pure attitudes of pitch, yaw, and roll.

The sign convention is based on the fin angular rotations that produce pure pitch. Thus, fin positive rotations (looking down the fin hinge toward the fin based) are:

a) Fin No. 1 - positive counterclockwise ($\triangle F_1$).

b) Fin No. 2 - positive counterclockwise ($\triangle F_2$).

c) Fin No. 3 - positive clockwise ($\triangle F_3$).

d) Fin No. 4 - positive clockwise ($\triangle F_4$).

Thus, the average value of the combined set is:

$$\delta p = \frac{(-\triangle F_1 - \triangle F_2 + \triangle F_3 + \triangle F_4)}{4} \text{ (roll)}$$

$$\delta q = \frac{(\triangle F_1 + \triangle F_2 + \triangle F_3 + \triangle F_4)}{4} \text{ (pitch)}$$

$$\delta r = \frac{(-\triangle F_1 + \triangle F_2 - \triangle F_3 + \triangle F_4)}{4} \text{ (yaw)} \quad .$$

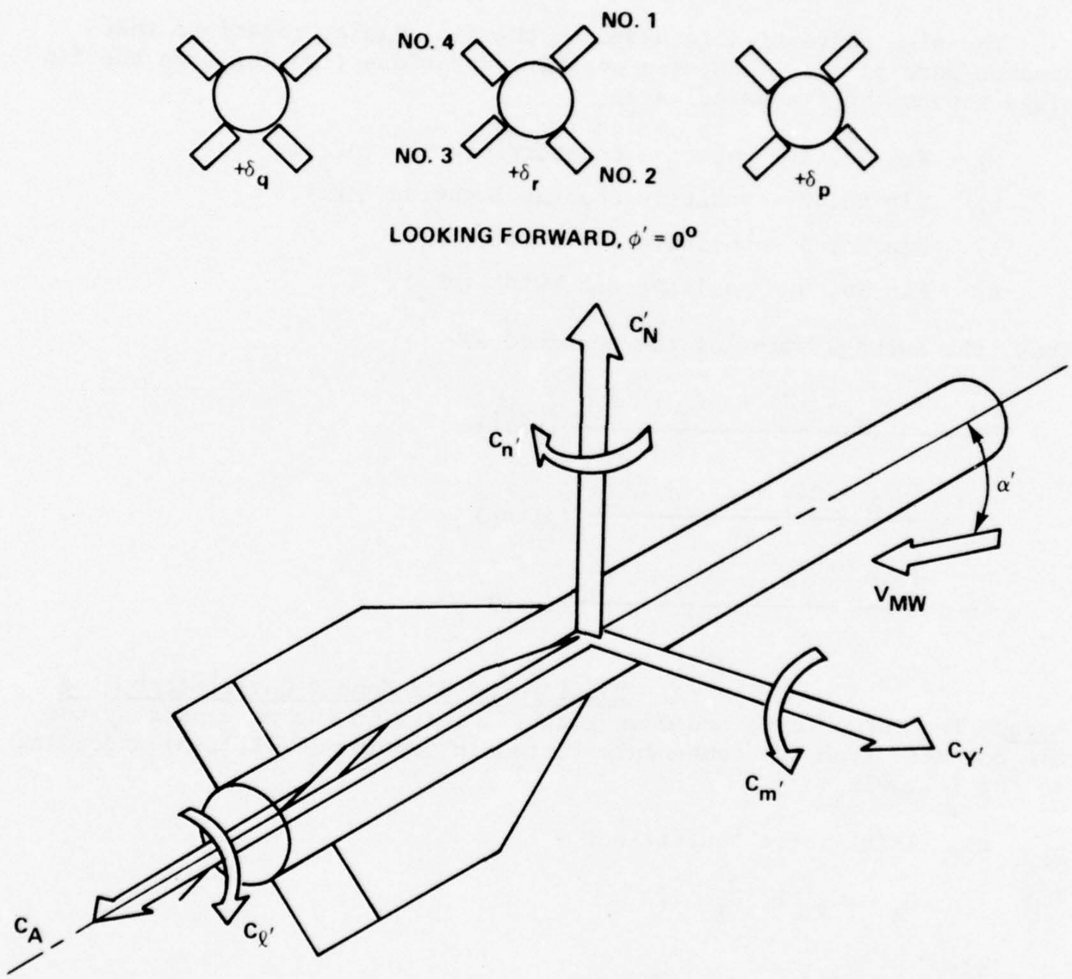
(2) Total Force and Moment Coefficient Wind Axes. The total force and moment coefficients in the wind axes system are computed from the components listed in Section III.B.1.(a) according to the following:

a) Axial force coefficient -

$$C_A = C_{X0} + \triangle C_X \quad .$$

b) Normal force coefficient -

$$C_{N'} = C_{N'(\alpha')} + \triangle C_{N'} \sin^2 2\Phi' + \left(\frac{C_{N'}}{\delta q}\right)_{\Phi'=0} (\delta q) \cos \Phi'$$
$$- \left(\frac{C_{N'}}{\delta r}\right)_{\Phi'=0} (\delta r) \sin \Phi' \quad .$$



NOTES:

1. C_N' IS ALWAYS IN THE PLANE OF α'
2. TAIL DEFLECTIONS SHOWN ARE TRAILING EDGE DISPLACEMENTS.
3. TAIL HINGE MOMENTS HAVE THE SAME DIRECTION AS DEFLECTIONS δ_q.

Figure 4. Aero sign conventions - wind axes.

c) Pitching moment coefficient -

$$C_{m'} = C_{m'(\alpha')} + \triangle C_{m'} \sin^2 2\Phi' + \left(\frac{C_{m'}}{\delta q}\right)_{\Phi'=0} (\delta q) \cos \Phi'$$

$$- \left(\frac{C_{m'}}{\delta r}\right)_{\Phi'=0} (\delta r) \sin \Phi' \quad .$$

d) Yawing moment coefficient -

$$C_{n'} = \triangle C_{n'} \sin 4\Phi' + \left(\frac{C_{n'}}{\delta r}\right)_{\Phi'=0} (\delta r) \cos \Phi'$$

$$+ \left(\frac{C_{n'}}{\delta q}\right)_{\Phi'=0} (\delta q) \sin \Phi' \quad .$$

e) Side force coefficient -

$$C_{Y'} = \triangle C_{Y'} \sin 4\Phi' + \left(\frac{C_{Y'}}{\delta r}\right)_{\Phi'=0} (\delta r) \cos \Phi'$$

$$+ \left(\frac{C_{Y'}}{\delta q}\right)_{\Phi'=0} (\delta q) \sin \Phi' \quad .$$

f) Rolling moment coefficient -

$$C_{\ell'} = \triangle C_{\ell'_{\text{Lugs}}} \sin \Phi' + \triangle C_{\ell'} \sin 4\Phi' + \left(\frac{C_{\ell'}}{\delta p}\right)_{\Phi'=0} (\delta p) \quad .$$

(3) Total Force and Moment Aerodynamic Coefficients - Body Axes. The aerodynamic forces and moments are computed in module A2 (forces and moments module) using the coefficients computed in this module. These forces and moments are computed in the missile body axes system; therefore, the coefficients previously computed must be transformed into the body system. The transformation is made based on the geometry given in Figure 3. Thus, the force and moment coefficients are:

a) Force coefficients -

$$C_X = C_A{}^*$$

$$C_Y = C_{Y'} \cos \Phi' - C_{N'} \sin \Phi'$$

$$C_Z = -C_{Y'} \sin \Phi' - C_{N'} \cos \Phi' \quad .$$

---

*Axial force coefficient C_A is actually opposite in sign of C_X. This sign difference is accounted for in subroutine A2 when the forces are computed.

b) Moment coefficients -

$$C_{\ell} = C_{\ell'}$$

$$C_m = C_{n'} \sin \Phi' + C_{m'} \cos \Phi'$$

$$C_n = C_{n'} \cos \Phi' - C_{m'} \sin \Phi' \quad .$$

c. <u>Initialization Subroutine</u>

Entry point A1I in module C4I initializes the individual fin settings at time = 0 from data input on type 3 input cards (Section IV.A). Initial values of the fin settings are computed from the combined fin settings that produce pitch (δq), yaw (δr), and or roll (δp). The individual fin settings computed are:

$$\Delta F_1 = -\delta p + \delta q - \delta r \quad .$$

$$\Delta F_2 = -\delta p + \delta q + \delta r \quad .$$

$$\Delta F_3 = \delta p + \delta q - \delta r \quad .$$

$$\Delta F_4 = \delta p + \delta q + \delta r .$$

The initialization equations for the individual fin settings are derived from the combined fin setting parameters under the constraint that

$$\Delta F_1 - \Delta F_2 - \Delta F_3 + \Delta F_4 = 0 \quad .$$

d. <u>Assumptions and Limitations</u>

1) The combined fin settings that produce pure attitudes of pitch, yaw, and roll are given in Figure 4. The sign convention is based on the fin angular rotations that produce pure pitch.

a) A positive fin setting for pitch (δq) gives a negative pitching moment.

b) A positive fin setting for yaw (δr) gives a negative yawing moment.

c) A positive fin setting for roll (δp) gives a negative rolling moment.

2) Due to vehicle fin symmetry, the fin pitch and yaw moment coefficients are equal and the fin normal and side force coefficients are equal.

a) $$\frac{C_{m'}}{\delta r} = \frac{C_{m'}}{\delta q} \quad .$$

b) $\frac{C_{n'}}{\delta q} = \frac{C_{m'}}{\delta q}$.

c) $\frac{C_{n'}}{\delta r} = \frac{C_{m'}}{\delta q}$.

d) $\frac{C_{Y'}}{\delta r} = \frac{C_{Y'}}{\delta q}$.

e) $\frac{C_{Y'}}{\delta q} = \frac{C_{N'}}{\delta q}$.

f) $\frac{C_{N'}}{\delta r} = \frac{C_{N'}}{\delta q}$.

g) $C_{mr} = C_{mq}$.

3) In subroutine A1, the symbol for normal force coefficient $C_{N'}$ was changed to $C_{Z'}$. According to Figure 3, the force coefficient $C_{Z'}$ has opposite sign of $C_{N'}$. However, this sign change was not observed in programming the equation. Thus, the equation for normal force coefficient uses the symbol $C_{Z'}$ but has the sign convention of $C_{N'}$.

4) Limitations imposed upon the angle of attack for the purpose of interpolating in the aero coefficient tables (Tables 1 through 4) are as follows:

a) $\alpha' \leq 20°$.

b) $\alpha \leq 20°$.

c) $\beta \leq 20°$.

e. Input/Output and Cross Reference of C-Array

The aero coefficient names are changed in A1 from that assigned in BLOCK DATA A and B. Table 2 is a cross reference of array names that are assigned in BLOCK DATA and the new names that are used in A1. Table 3 is a cross reference of symbols used in the text and their respective Fortran symbols.

2. A2 - Forces and Moments

a. Function Description

This module computes aerodynamic forces and moments acting on the vehicle, computes forces and moments acting on

TABLE 1. INPUT FROM OTHER MODULES - MODULE A1

Fortran Symbol	Symbol Used in Text	C Index	Definition
VMACH	MACH	204	Instantaneous value of Mach number
BALPHA	α	367	Instantaneous value of the vertical angle of attack, measured from the projection of the missile velocity with respect to the wind into the X_B - Z_B plane and the X_B axis (deg)
BALPHY	β	368	Instantaneous value of the horizontal angle of attack, measured from the projection of the missile velocity relative to the wind into the X_B - Z_B plane and the velocity relative to the wind (deg)
BALPHP	α'	369	Instantaneous value of the total angle of attack between vehicle X_B axis and the relative wind velocity (deg)
BPHIP	Φ'	370	Instantaneous value of the aerodynamic roll angle between the plane containing the Z_B - X_B axes and the plane containing the X_B velocity vector relative to the wind (deg)
BSURF1	ΔF_1	1103	Angular fin setting of fin No. 1, measured positive, counterclockwise (deg)
BSURF2	ΔF_2	1107	Angular fin setting of fin No. 2, measured positive, counterclockwise (deg)
BSURF3	ΔF_3	1111	Angular fin setting of fin No. 3, measured positive, clockwise (deg)
BSURF4	ΔF_4	1115	Angular fin setting of fin No. 4, measured positive, clockwise (deg)

TABLE 2. AERO COEFFICIENT COMMON BLOCK CROSS REFERENCE

	COMMON BLOCK	BLOCK DATA Arrays	A1 Arrays
	NOS	NCX(6), NCZ(4), NCXO(2), NCZD(6)	NCX(6), NCN(4), NCO(2), NCD(6)
A	CXARG	ALP(6), AM(3)	CXA(9)
	CZARG	ALP1(6), AM1(4)	CZA(10)
	CXOARG	AMZ(8)	CXB(8)
	CLDARG	ALP3(6), DEF(4), AM3(4)	CLA(14)
	CXFUN	CX(18)	CXF(18)
	CZFUN	CN(24)	CZF(24)
	DCZFUN	DCN(24)	DCF(24)
	CMFUN	CM(24)	CMF(24)
	DCMFUN	DCM(24)	DMF(24)
	CXOFUN	CXO(8)	COF(8)
	CN2FUN	CN2(24)	C2F(24)
	CY2FUN	CY2(24)	CYF(24)
B	CL2FUN	CL2(24)	CLF(24)
	CL3FUN	CL3(24)	C3F(24)
	CZDFUN	CN1(24), CN5(24), CN3(24), CN4(24)	CDF(92)
	CMDFUN	CM1(24), CM2(24), CM3(24), CM4(24)	MDF(92)
	CLDFUN	CL1(24), CL5(24), CL6(24), CL4(24)	DLF(92)
	CMQFUN	CMQ(24)	CQF(24)
	CLPFUN	CLP(24)	CPF(24)

TABLE 3. AERO COEFFICIENT MATHEMATICAL SYMBOL AND FORTRAN SYMBOL CROSS REFERENCE

Fortran Symbol	Symbol Used in Text	COMMON BLOCK Starting Point
CXO	C_{X0}	COF(1)
CX	ΔC_X	CXFUN(1)
CN	$C_{N'(\alpha')}$	CZFUN(1)
DCN	$\Delta C_{N'}$	DCZFUN(1)
CM	$C_{m'(\alpha')}$	CMFUN(1)
DCM	$\Delta C_{m'}$	DCMFUN(1)

TABLE 3. (Concluded)

Fortran Symbol	Symbol Used in Text	COMMON BLOCK Starting Point
CN2	$\Delta C_{n'}$	CN2FUN(1)
CY2	$\Delta C_{Y'}$	CY2FUN(1)
CL2	$\Delta C_{\ell'}$	CL2FUN(1)
CL3	$\Delta C_{\ell'_{Lugs}}$	CL3FUN(1)
CN1	$\left(\frac{C_{N'}}{\delta q}\right)_{\phi'=0}$	CZDFUN(1)
CN5		CZDFUN(25)
CN3		CZDFUN(49)
CN4		CZDFUN(73)
CL1	$\left(\frac{C_{\ell'}}{\delta p}\right)_{\phi'=0}$	CLDFUN(1)
CL5		CLDFUN(25)
CL6		CLDFUN(49)
CL4		CLDFUN(73)
CM1	$\left(\frac{C_{m'}}{\delta q}\right)_{\phi'=0}$	CMDFUN(1)
CM2		CMDFUN(25)
CM3		CMDFUN(49)
CM4		CMDFUN(73)
CMQ	C_{mq}	CMQFUN(1)
CLP	$C_{\ell p}$	CLPFUN(1)

TABLE 4. OUTPUT - MODULE A1

Fortran Symbol	Symbol Used in Text	C Index	Definition
CX	C_X	1203	Total axial force coefficient value in body axis system
CY	C_Y	1204	Total side force coefficient value in body axis system
CZ	C_Z	1205	Total normal force coefficient value in body axis system
CLP	$C_{\ell p}$	1206	Roll moment damping coefficient
CMQ	C_{mq}	1207	Pitch moment damping coefficient
CNR	C_{nr}	1208	Yaw moment damping coefficient
CL	C_ℓ	1209	Total rolling moment coefficient value in body axis system
CM	C_m	1210	Total pitching moment coefficient value in body axis system
CN	C_n	1211	Total yawing moment coefficient value in body axis system
BDL	δp	1231	Average value of the combined fin settings for roll control (deg)
BMD	δq	1232	Average value of the combined fin settings for pitch control (deg)
BDN	δr	1233	Average value of the combined fin settings for yaw control (deg)

the missile lugs due to launch rail motion and missile motion, and sums up all forces and moments acting on the vehicle computed in this module and those from other sources (such as thrust which is computed in A3). The resulting forces and moments output from this module are the total external forces and moments.

The aerodynamic forces and moments consist of those forces and moments acting on the vehicle and the moments on the movable control surface hinge points.

The aerodynamic forces and moments acting on the vehicle are computed using the aerodynamic coefficients determined by table lookup in subroutine A1.

Lug forces and moments are computed for missile motion along the launch rail if the input flag OPTN4 is greater than zero. The lug forces and moments are computed for two flight phases; viz, both lugs on the rail and rear lug only on the rail. Printed output concerning the events along the rail are controlled by this module. The events are (1) front lug rail clearance and (2) rear lug rail clearance. When the front lug clears the rail, the output is:

FRONT LUG CLEARS RAIL, T = (time) .

REL VEL = (airspeed), PITCH MOMENT = (pitching moment due to rear lug) .

TIPOFF RATES - ROLL, PITCH, and YAW missile rates following rear lug drop-off.

The output pitching moment is the pitching moment computed at the first time point after front lug clearance. No interpolation is made to determine the exact time of front rail clearance.

When the rear lug clears the rail, the output is:

REAR LUG CLEARS RAIL, T = (time) .

REL VEL = (airspeed), RAIL FORCE = (the Z-component of the rail force) .

The output rail force is the force exerted on both the front and rear lug at the time point just prior to front lug rail clearance. No interpolation is made to determine the exact time of rear lug rail clearance.

b. Equations

(1) Moments and Forces due to Aerodynamics and Thrust. Conventional aerodynamic force and moment equations are used to compute the forces and moments in the missile body axis system. They are

a) Vehicle aero forces -

$$F_{AXB} = P_D S_A (-C_X)^*$$

$$F_{AYB} = P_D S_A (C_Y)$$

$$F_{AZB} = P_D S_A (C_Z) \quad ,$$

where P_D is dynamic pressure, S_A is the vehicle reference area, and the C subscripts are the aerodynamic coefficients.

b) Vehicle aero moments -

$$M_{AXB} = \left(C_\ell + C_{\ell p} \left(\frac{S_L}{2V_{MW}} \right) \omega_P \right) P_D S_A S_L$$

$$M_{AYB} = \left(C_m + C_{mq} \left(\frac{S_L}{2V_{MW}} \right) \omega_Q \right) P_D S_A S_L$$

$$M_{AZB} = \left(C_n + C_{nr} \left(\frac{S_L}{2V_{MW}} \right) \omega_R \right) P_D S_A S_L \quad ,$$

where S_L is the vehicle reference length; C_ℓ, C_m, and C_n are the aero moment coefficients; $C_{\ell p}$, C_{mq}, and C_{nr} are the damping moment coefficients; V_{MW} is the missile velocity relative to the wind; and the ω subscripts are the vehicle rotation rates about their respective axes.

Due to a CG shift from the vehicle reference axes, delta moments due to aerodynamic forces and thrust are computed. The assumption that the shift occurs only along the X-axis is made. Thus,

$$\Delta Y_{CG} = 0$$

---

*C_X is sent into this module with the sign convention of C_A. Therefore, the sign change is made here to account for the sign convention used in this program, namely $C_X = -C_A$.

and

$$\Delta Z_{CG} = 0 \quad .$$

Therefore, delta body moments due to the CG shift are:

$$\Delta M_X = 0$$

$$\Delta M_Y = (F_{AZB} + F_{TZ})\ \Delta X_{CG}$$

$$\Delta M_Z = (F_{AYB} + F_{TY})\ \Delta X_{CG} \quad ,$$

where F_{TY} and F_{TZ} are the thrust misalignment forces along the Y and Z body axes (computed in A3), and ΔX_{CG} is the CG shift as shown in Figure 5.

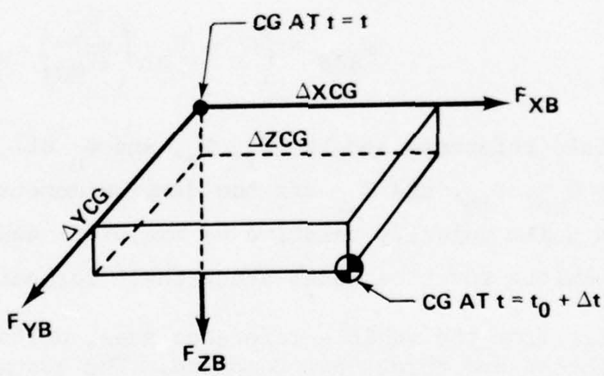


Figure 5. CG shift.

The sum total of the external body forces and moments computed in this module and input from the engine module (A3) are

$$\left.\begin{aligned} F_{XB} &= F_{AXB} + F_{TX} \\ F_{YB} &= F_{AYB} + F_{TY} \\ F_{ZB} &= F_{AZB} + F_{TZ} \end{aligned}\right\} \quad \text{(Components of total body forces)}$$

$$\left.\begin{aligned} M_{XB} &= M_{AXB} + M_{XTH} \\ M_{YB} &= M_{AYB} + \Delta M_Y + M_{YTH} \\ M_{ZB} &= M_{AZB} + \Delta M_Z + M_{ZTH} \end{aligned}\right\} \quad \text{(Components of total body forces)}$$

where F_{TX} is the thrust misalignment along the X-axis, and M_{XTH}, M_{YTH}, and M_{ZTH} are the body moments due to the initial thrust misalignment (at $t = 0$) computed in the engine module (A3). The missile lug forces and moments in the previously mentioned equations are added while the missile is still on the launch rail if the flag OPTN4 is set to non-zero.

(2) <u>Moments and Forces Due to Lugs</u>. The moments and forces acting on the missile while moving along the launch rail are shown in Figure 6. The variable symbols on the figure are defined as:

$\bar{F}_{TH}$ - Thrust vector composed of (F_{TX}, F_{TY}, F_{TZ}).

$\bar{F}_{AERO}$ - Aerodynamic force vector composed of (F_{AXB}, F_{AYB}, F_{AXB}) .

$\bar{F}_{L1}$ - Force acting on front lug .

$\bar{F}_{L2}$ - Force acting on rear lug .

$\bar{W}_B$ - Weight vector.

$\bar{M}$ - Total moment vector .

$\bar{d}_1$ - Front lug moment arm .

$\bar{d}_2$ - Rear lug moment arm .

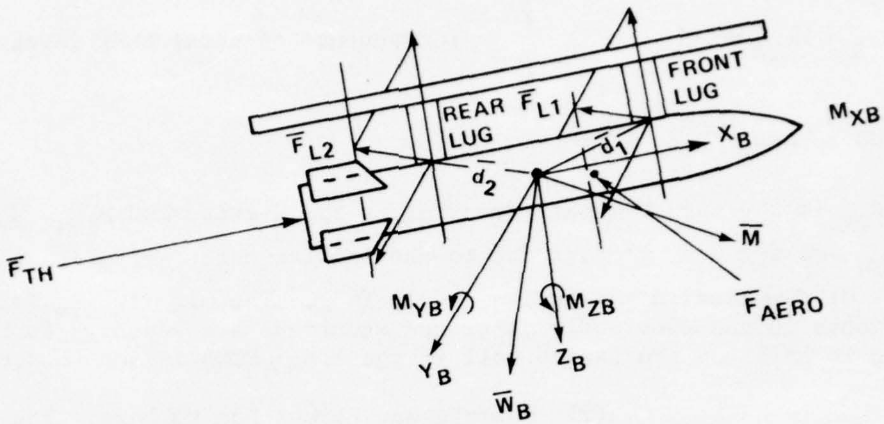


Figure 6. Missile free-body diagram.

The forces and moments are due to the missile motion and the rail motion (helicopter motion). The effect of rail motion is modeled as a moment [2] (computed in subroutine LTRAN) and is added to the total moments acting on the missile.

The forces and moments acting on the missile due to the lugs for the two flight phases are given as follows:

(a) Phase 1 - Missile Flight with Both Lugs on the Rail - Lug forces are:

$$F_{XLUG} = 0$$

$$F_{YLUG} = -(F_{YB} + mg\ C_{23})$$

$$F_{ZLUG} = mg\ (\ddot{Z}_{RAIL} - C_{33}) - F_{ZB} \quad ,$$

where C_{23} and C_{33} are the (2,3) and (3,3) elements of the earth-to-body transformation matrix, M, defined in Section III.B.7, and $\ddot{Z}_{RAIL}$ is an unused rail acceleration term that is zeroed out in A2.

Lug moments are:

$$M_{XLUG} = - M_{XB} \quad .$$

$$M_{YLUG} = - M_{YB} \quad .$$

$$M_{ZLUG} = - M_{ZB} \quad .$$

(b) Phase 2 - Missile Flight After the First Lug Clears Rail - Lug forces are:

$$F_{XLUG} = 0 \quad .$$

$$F_{YLUG} = \frac{m\left(d_{x2}\,\frac{M_{ZB}}{I_Z}\right) - \left((F_{YB} + mgC_{23})\right)}{\left(1 + d_{x2}^2\,\frac{m}{I_Z}\right)} \quad .$$

$$F_{ZLUG} = \frac{-m\left(\frac{d_{x2}}{I_Y}\,M_{YB} - Z_{RAIL}\right) - \left((F_{ZB} + mgC_{33})\right)}{\left(1 + d_{x2}^2\,\frac{m}{I_Y}\right)}$$

Lug moments are:

$$M_{XLUG} = - M_{XB}$$

$$M_{YLUG} = d_{x2}\,F_{ZLUG}$$

$$M_{ZLUG} = -d_{x2}\,F_{ZLUG} \quad .$$

(3) Total External Forces and Moments. The sum of all external forces and moments acting on the missile are:

a) Force components -

$$F_{XBA} = F_{AXB} + F_{TX} + F_{XLUG} \quad .$$

$$F_{YBA} = F_{AYB} + F_{TY} + F_{YLUG} \quad .$$

$$F_{ZBA} = F_{AZB} + F_{TZ} + F_{ZLUG} \quad .$$

b) Moment components -

$$M_{XBA} = M_{AXB} + M_{XTH} + M_{XLUG} + M_{X} \quad .$$

$$M_{YBA} = M_{AYB} + M_{YTH} + M_{YLUG} + \Delta M_{Y} + M_{Y} \quad .$$

$$M_{ZBA} = M_{AZB} + M_{ZTH} + M_{ZLUG} + \Delta M_{Z} + M_{Z} \quad .$$

c. Random Error Sources

(1) Launch Transient Model. The variables associated with the Monte Carlo launch transient models are given in Section III.B.2.e. An 8-card is used to select any one of these models (roll, pitch, or yaw) as a Monte Carlo variable. Roll is the only one of the three that requires specification of a probability distribution on the 8-card. The pitch and yaw models do require 8-cards; however, the probability distribution input fields are left blank because pitch and yaw are randomized indirectly, as explained in Reference 3.

A mean value of roll rate (WPTO) is input by 3-card. Mean values of pitch and yaw rate are not input, because the mean and distribution of these two variables are determined from solution of the forcing function, F(t). However, the peak amplitude of pitch (AMP2) and yaw (AMP1) moments (due to helicopter vibration) must be input by 3-card. In addition, the flag, VIB, defined in Section III.B.2.e must be input equal to one.

(2) Pitch and Yaw Randomization Independent of Launch Transient Model. Pitch and yaw tipoff rates may be randomized from an input probability distribution by inputting the C-indices

of pitch and yaw rates on an 8-card. This capability was added as an option to directly randomize as opposed to indirectly randomizing pitch and yaw rates as previously mentioned. Use of this option will generate instantaneous changes in pitch and yaw rates at time of rear shoe rail exit. This option was added primarily to allow randomization of pitch and yaw rates for launch from a tower or ground vehicle in which there are no launcher vibrations. However, this option can be exercised simultaneously with the previously mentioned vibration model. Roll rate randomization previously described applies equally to helicopter or ground launchers.

d. Input/Output Variables and Cross Reference of C-Array

Tables 5 through 7 present the input/output variables and cross reference of the C-array of module A2.

TABLE 5. INPUT FROM DATA CARDS - MODULE A2

Fortran Symbol	Symbol Used in Text	C Index	Definition
RFAREA	S_A	1306	Aerodynamic cross section reference area (ft^2).
RFLGTH	S_L	1307	Aerodynamic reference length used to compute also moments (ft).
RLUG		1316	Spacing between the front and rear missile lugs (ft).
RAIL	RAIL	1317	Distance between rear of front lug and front of rail (ft).
AGRAV	g	1627	Acceleration due to gravity (ft/sec^2).
OPTN4		3504	Rail launcher dynamics and fire selector option switch: 0 - no rail dynamics - direct fire 1 - compute rail dynamics - direct fire 2 - compute rail dynamics - indirect fire.

TABLE 6. INPUT FROM OTHER MODULES - MODULE A2

Fortran Symbol	Symbol Used in Text	C Index	Definition
PDYNMC	P	203	Dynamic pressure (lb/ft^2)
VMACH	M	204	Mach number
VAIRSP	V_{MW}	207	Magnitude of velocity relative to the wind (ft/sec)
RANGO	$RANG_0$	380	Magnitude of separation distance between rail and missile (ft)
CX	C_X	1203	Aero axial force coefficient
CY	C_Y	1204	Aero side force coefficient
CZ	C_Z	1205	Aero normal force coefficient
CLP	$C_{\ell p}$	1206	Aero roll damping coefficient
CMQ	C_{mq}	1207	Aero pitch damping coefficient
CNR	C_{nr}	1208	Aero yaw damping coefficient
CL	C_ℓ	1209	Aero rolling moment coefficient
CM	C_m	1210	Aero pitching moment coefficient
CN	C_n	1211	Aero yawing moment coefficient
FMX	M_X	1737	Components of rail moments caused by helicopter vibration (ft/lb)
FMY	M_Y	1741	
FMZ	M_Z	1745	
FMXTH	M_{XTH}	1320	Components of thrust misalignment moments about body axes (ft-lb)
FMYTH	M_{YTH}	1321	
FMZTH	M_{ZTH}	1322	
RLCG	ΔX_{CG}	1422	CG shift along X_B-axis (ft)

TABLE 6. (Concluded)

Fortran Symbol	Symbol Used in Text	C Index	Definition
FTHX	F_{TX}	1411	Thrust misalignment components along body axes (lb)
FTHY	F_{TY}	1412	
FTHZ	F_{TZ}	1413	
CFA23	C_{23}	1723	Element (2,3) of earth-to-body transformation matrix, M
WP	ω_P	1739	Roll rate about X_B-axis (deg/sec)
WQ	ω_Q	1743	Pitch rate about Y_B-axis (deg/sec)
WR	ω_R	1747	Yaw rate about Z_B-axis (deg/sec)
T	t	2000	Flight time (sec)
CFA33	C_{33}	1735	Element (3,3) of earth-to-body transformation matrix
WPTO	ω_{PTO}	1738	Tipoff roll rate (deg/sec)
AMP2	A_m	1742	Peak amplitude of pitch moment forcing function (ft/lb)
AMP1	A_m	1746	Peak amplitude of yaw moment forcing function (ft/lb)
VIB		626	Launch transient, vibration flag (pitch and yaw only): 0 - no vibration 1 - run with vibration

TABLE 7. OUTPUT - MODULE A2

Fortran Symbol	Symbol Used in Text	C Index	Definition
FXBA	F_{XB}	1300	X_B - component of all external forces acting on the missile (axial forces) (lb)
FYBA	F_{YB}	1301	Y_B - component of all external forces acting on the missile (side force) (lb)
FZBA	F_{ZB}	1302	Z_B - component of all external forces acting on the missile (normal forces) (lb)
FMXBA	M_{XB}	1303	X_B - component of all external moments acting on the missile (rolling moment) (ft-lb)
FMYBA	M_{YB}	1304	Y_B - component of all external moments acting on the missile (pitching moment) (ft-lb)
FMZBA	M_{ZB}	1305	Z_B - component of all external moments acting on the missile (yawing moment) (ft-lb)
FMH1	M_{H1}	1309	Hinge moment about aerodynamics control surface, fin No. 1 (ft-lb)
FMH2	M_{H2}	1310	Hinge moment about aerodynamics control surface, fin No. 2 (ft-lb)
FMH3	M_{H3}	1311	Hinge moment about aerodynamics control surface, fin No. 3 (ft-lb)
FMH4	M_{H4}	1312	Hinge moment about aerodynamics control surface, fin No. 4 (ft-lb)
FMXLUG	M_{XLUG}	1323	(1) X_B - component of moment counter-acted by the front and rear lugs when both lugs are on the rail (2) X_B - component of moment acting on the rear lug when the front lug has cleared the rail (rolling moment, ft-lb).

TABLE 7. (Concluded)

Fortran Symbol	Symbol Used in Text	C Index	Definition
FMYLUG	M_{XLUG}	1324	(1) Y_B - component of moment counter-acted by the front and rear lugs when both lugs are on the rail (2) Y_B - component of moment acting on the rear lug when the front lug has cleared the rail (pitching moment, ft-lb)
FMZLUG	M_{ZLUG}	1325	(1) Z_B - component of moment counter-acted by the front and rear lug when the lugs are on the rail (2) Z_B - component of moment acting on the rear lug when the front lug has cleared the rail (yawing moment, ft-lb)

e. Monte Carlo Input Variables and Cross Reference of C-Array

Table 8 presents the Monte Carlo input variables and cross reference of the C-array of module A2.

3. A3 - Engine Module

a. Function Description

The engine module calculates the total thrust (FTHRST) as a function of time, using a table look-up with linear interpolation between points. If the input engine misalignment switch, QNALGN, is greater than zero, the components of thrust (FTHX, FTHY, and FTHZ) along the body axes, X_B, Y_B, and Z_B, are calculated for use in determining translational accelerations. The corresponding moments (FMXTH, FMYTH, and FMZTH) are also calculated for use in determining rotational accelerations.

Regardless of the setting of the thrust misalignment switch, the engine module calculates instantaneous values for the time derivative of impulse (UIMPD), weight of burned propellant (UDWP), total vehicle mass (DMASS), change in CG offset due to burned propellant (RDELCG), moments of inertia (FMIX, FMIY, and FMIZ), and distance between the CG and rear lug (RLCG).

TABLE 8. MONTE CARLO INPUT - MODULE A2

Program Variable Name of Error Source	C Index of Error Source	Program Module Calling MCARLO	MCARLO Flag*		Definition
			Name	Index	
WPTO	1738	A3I, A2		1738	Mean tipoff roll rate (deg/sec)
AMP2	1742	A3I, A2		1742	Peak amplitude of pitching moment forcing function (ft/lb)
AMP1	1746	A3I, A2		1746	Peak amplitude of yawing moment forcing function (ft/lb)
WQ	1743	A2		1743	Pitch rate (deg/sec)
WR	1747	A2		1747	Yaw rate (deg/sec)

*MCARLO is flagged by the C-index of this variable in the calling module.

When MCARLO is flagged by this C-index, a random number will be returned from MCARLO for the error source in the first column.

A burnout switch (QBURN) is set to one when the first zero value is returned from the thrust table (indicating propellant burnout). After burnout, the engine module returns control to the calling routine without performing any calculations, and engine related variables retain their burnout values.

b. Equations

(1) Calculated when Thrust Misalignment Option is Selected (QNALGN > 0).

$$
\left.\begin{aligned}
FTHX &= (FTHRST)\cos(\alpha_T) \\
FTHY &= -(FTHRST)\sin(\alpha_T)\sin(\Phi_T) \\
FTHZ &= (FTHRST)\sin(\alpha_T)\cos(\Phi_T)
\end{aligned}\right\}\quad \text{Thrust components along body axes } (X_B, Y_B, Z_B)
$$

$$
\left.\begin{aligned}
FMXTH &= -(FTHY)(RFZCG) + (FTHZ)(RFYCG) \\
FMYTH &= (FTHX)(RFZCG) + (FTHZ)(RFXCG) \\
FMZTH &= -(FTHX)(RFYCG) - (FTHY)(RFXCG)
\end{aligned}\right\}\quad \text{Moment components about } X_B, Y_B, \text{ and } Z_B \text{ axes due to thrust misalignment and thrust displacement from missile CG}
$$

where the terms on the right-hand side of the equations are defined in Figure 7.

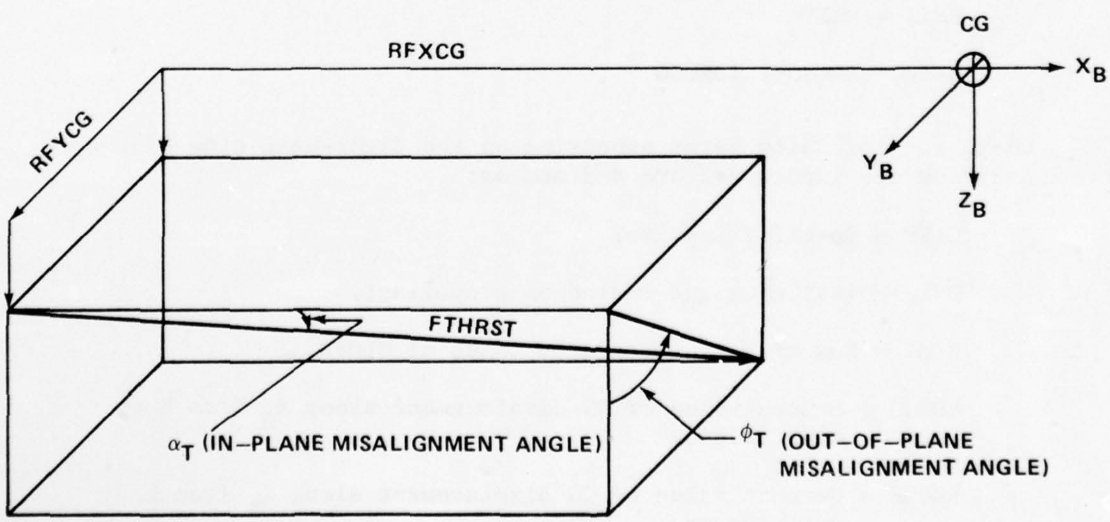


Figure 7. Thrust vector geometry.

Thus, the magnitude of the thrust vector is FTHRST, its direction is specified by the angles α_T and ϕ_T, and RFXCG, RFYCG, and RFZCG, are, respectively, the thrust application offsets from the missile CG along X_B, Y_B, and Z_B. Note the values of RFXCG, RFYCG, and RFZCG are to be input positive in the direction of the arrows shown in Figure 7 to obtain the correct sign for the moments.

(2) Calculated Regardless of the Thrust Misalignment Option.

$$UIMPD = FTHRST$$

$$UDWP = \frac{UIMP}{CISP}$$

$$DMASS = \frac{(DWT - UDWP)}{32.174}$$

$$RDELCG = RDCGO - \frac{(RDCGO - RDCGF)(UDWP)}{DWP}$$

$$FMIX = \frac{FMIXO\ (DWT - UDWP)}{DWT}$$

$$FMIY = \frac{FMIYO\ (DWT - UDWP)}{DWT}$$

$$FMIZ = FMIY$$

$$RLCG = RLCGO + RDELCG \quad ,$$

where the following terms appearing on the right-hand side of the equation are inputs and are defined as:

CISP = Specific impulse.

DWT = Missile weight including propellant.

UIMP = Numerically integrated value of UIMPD.

RDCGO = Launch value of CG displacement along X_B from body axes origin.

RDCGF = Burnout value of CG displacement along X_B from body axes origin.

RLCGO = Distance between launch CG and rear lug.

FMIXO, FMIYO, FMIZO = Initial moments of inertia about X_B, Y_B, and Z_B axes, respectively .

c. Assumptions

Although the instantaneous CG displacement from the body axes origin (RDELCG) is calculated for use in the forces and moments module (A2), the CG shift is not used in the calculations for the instantaneous value of moments of inertia; the moments of inertia are modified only for the changing mass.

d. Initialization Subroutine

The engine module initialization subroutine (A3I) performs functions unrelated to the engine when the trajectory simulation initialization time is prior to engine burnout. Specifically, A3I initializes the angular body rates (ω_P, ω_Q, and ω_R) components of the angle of attack and roll angle (BALPHA, BALPHY, and BPHIP) to zero when simulation initiation is prior to burnout. The significance of these initialization actions is that angular rates and angles of attack will always be initially zero, regardless of the input values. This results from the fact that A3I is called after the input subroutine, OINPT1, and prior to the modules in the integration loop.

When simulation initiation is after engine burnout, A3I zeros all thrust components and sets moments of inertia, CG shifts, and vehicle mass to burnout values.

A3I also initializes several Monte Carlo variables. Thrust misalignment errors due to radial offset and nozzle misalignment are set.

A3I initializes the roll transient model used in conjunction with the optional optical contrast seeker described in Reference 3. Section III.B.3.g contains a list of all Monte Carlo variables initialized in A3I.

e. Random Error Sources - Thrust Misalignment/Offset

Thrust misalignment errors due to radial offset and nozzle misalignment, shown in Figure 8, are modeled in module A3. Monte Carlo values are generated in module A3I. Mean values of the thrust errors are set by input data cards.

When making runs that include thrust misalignment/offset errors, the program flag QNALGN must be set equal to one. If it is not, the logic to compute thrust component values from the Monte Carlo error values will be bypassed in module A3.

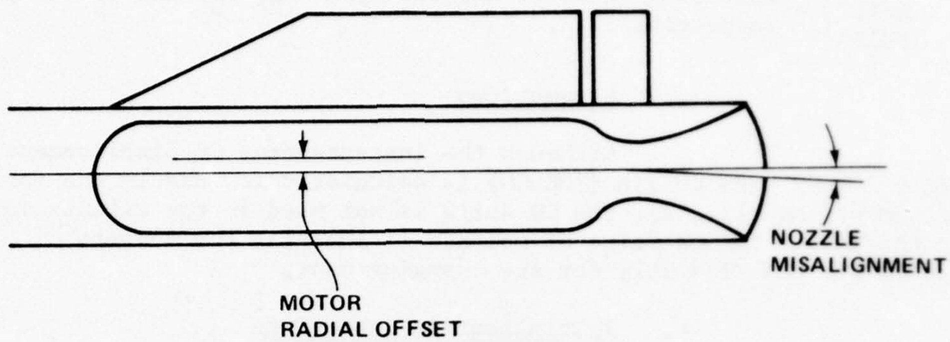


Figure 8. Thrust misalignment/offset error model.

The variables associated with the thrust misalignment/offset error model are given in Section III.B.3.g.

f. Input/Output Variables and Cross Reference of C-Array

Tables 9 and 10 present the input/output variables and cross reference of the C-array for module A3.

g. Monte Carlo Input Variables and Cross Reference of C-Array

Tables 11 and 12 present the Monte Carlo input variables and cross reference of C-array (launch transient and thrust misalignment variables, respectively).

4. C1 - Autopilot Module

a. Function Description

The autopilot, illustrated in the block diagram of Figure 9, provides pitch and yaw guidance signal shaping, short period rate damping, and navigation ratio mechanization required to implement the proportional navigation homing guidance technique. In addition, the autopilot maintains roll attitude by means of a roll control network. Pitch and yaw feedback is accomplished with rate gyros, while roll feedback is through a 2 DOF attitude gyro (modeled in G5). Gravity effects are continuously compensated for by the addition of a G_{BIAS} term. The autopilot has three modes of operation of the seeker. They are direct fire, direct fire-delayed guidance, and indirect fire.

TABLE 9. INPUT FROM DATA CARDS - MODULE A3

Fortran Symbol	Symbol Used in Text	C Index	Definition
RFXCG RFYCG RFZCG	RFXCG RFYCG RFZCG	1313 1314 1315	Thrust application point offset along X_B, Y_B, and Z_B body axes, from CG
BALPHT BPHIT	αT ΦT	1401 1402	Engine misalignment angles (Figure 7)
QNALGN	QNALGN	1403	Engine misalignment option switch (QNALGN > 0 selects engine misalignment)
CISP	CISP	1414	Specific impulse (sec)
DWT	DWT	1415	Missile weight (lb)
DWP	DWP	1416	Propellant weight (lb)
RDCGO	RDCGO	1417	Launch value of CG displacement along X-body axis (ft)
RDCGF	RDCGF	1418	Burnout value of CG displacement along X-body axis (ft)
FMIXO FMIYO	FMIXO FMIYO	1419 1420	Initial moments of inertia about X and Y body axes. (Due to assumed missile axial symmetry, FMIZF is taken to be equal to FMIYF) (slug-ft^2)
RLCGO	RLCGO	1421	Distance between launch CG and rear lug (ft).

TABLE 10. OUTPUTS - MODULE A3

Fortran Symbol	Symbol Used in Text	C Index	Definition
RDELCG	RDELCG	1308	Change in CG shift due to burned propellant (ft)
FMXTH FMYTH FMZTH	FMXTH FMYTH FMZTH	1320 1321 1322	Moment of force components about X, Y, and Z body axes due to engine misalignment and displacement of thrust point application from CG (ft-lb)

TABLE 10. (Concluded)

Fortran Symbol	Symbol Used in Text	C Index	Definition
FTHX FTHY FTHZ	FTHX FTHY FTHZ	1411 1412 1413	Translational thrust components along X, Y, and Z body axes (lb)
RLCG	RLCG	1422	Distance between the instantaneous CG and rear lug (ft)
DMASS	DMASS	1628	Instantaneous missile mass (slug)
FMIX FMIY FMIZ	FMIX FMIY FMIZ	1748 1749 1750	Instantaneous values of moments of inertia about X, Y, and Z body axes (slug-ft^2)

TABLE 11. LAUNCH TRANSIENT MONTE CARLO VARIABLES

Program Variable Name of Error Source	C Index of Error Source	Program Module Calling MCARLO	MCARLO Flag*		Definition
			Name	Index	
WPTO	1738	A3I, A2		1738	Mean tipoff roll rate (deg sec)
AMP2	1742	A3I, A2		1742	Peak amplitude of pitching moment forcing function (ft/lb)
AMP1	1746	A3I, A2		1746	Peak amplitude of yawing moment forcing function (ft/lb)

*MCARLO is flagged by the C-index of this variable in the calling module.

When MCARLO is flagged by this C-index, a random number will be returned from MCARLO for the error source in the first column.

TABLE 12. THRUST MISALIGNMENT MONTE CARLO VARIABLES

Program Variable Name of Error Source	C Index of Error Source	Program Module Calling MCARLO	MCARLO Flag*		Definition
			Name	Index	
RFXCG	1313	A3I	RFXCG	1313	Thrust X-offset (ft)
RFYCG	1314	A3I	RFYCG	1314	Thrust Y-offset (ft)
RFZCG	1315	A3I	RFZCG	1315	Thrust Z-offset (ft)
BALPHT	1401	A3I	BALPHT	1401	Thrust in-plane misalignment angle (deg)
BPHIT	1402	A3I	BPHIT	1402	Thrust out-of-plane misalignment angle (deg)

NOTE: See Figure 7 for pictorial illustration of these parameters.

*MCARLO is flagged by the C-index of this variable in the calling module.

When MCARLO is flagged by this C-index, a random number will be returned from MCARLO for the error source in the first column.

(1) Direct Fire. In the direct fire mode, the seeker is locked on to the target (OPTN4 < 1, TRKZY = 1)* and the autopilot pitch and yaw channels receive guidance signals from the seeker. Normal terminal homing guidance is in effect. The pitch and yaw signals may be biased by input variables Q_{BIAS} and R_{BIAS}.

(2) Direct Fire-Delayed Guidance. In the direct fire-delayed guidance mode, the seeker is locked onto the target (OPTN4 < 1, TRKZY = 1, TDY > 0). However, the autopilot receives no guidance signal from the seeker until a specified flight time of TDY seconds has been reached. Preprogrammed guidance commands, Q_{BIAS},

*TRKZY is not a user input parameter. It is set in the seeker initialization module based upon the input value of OPNT4.

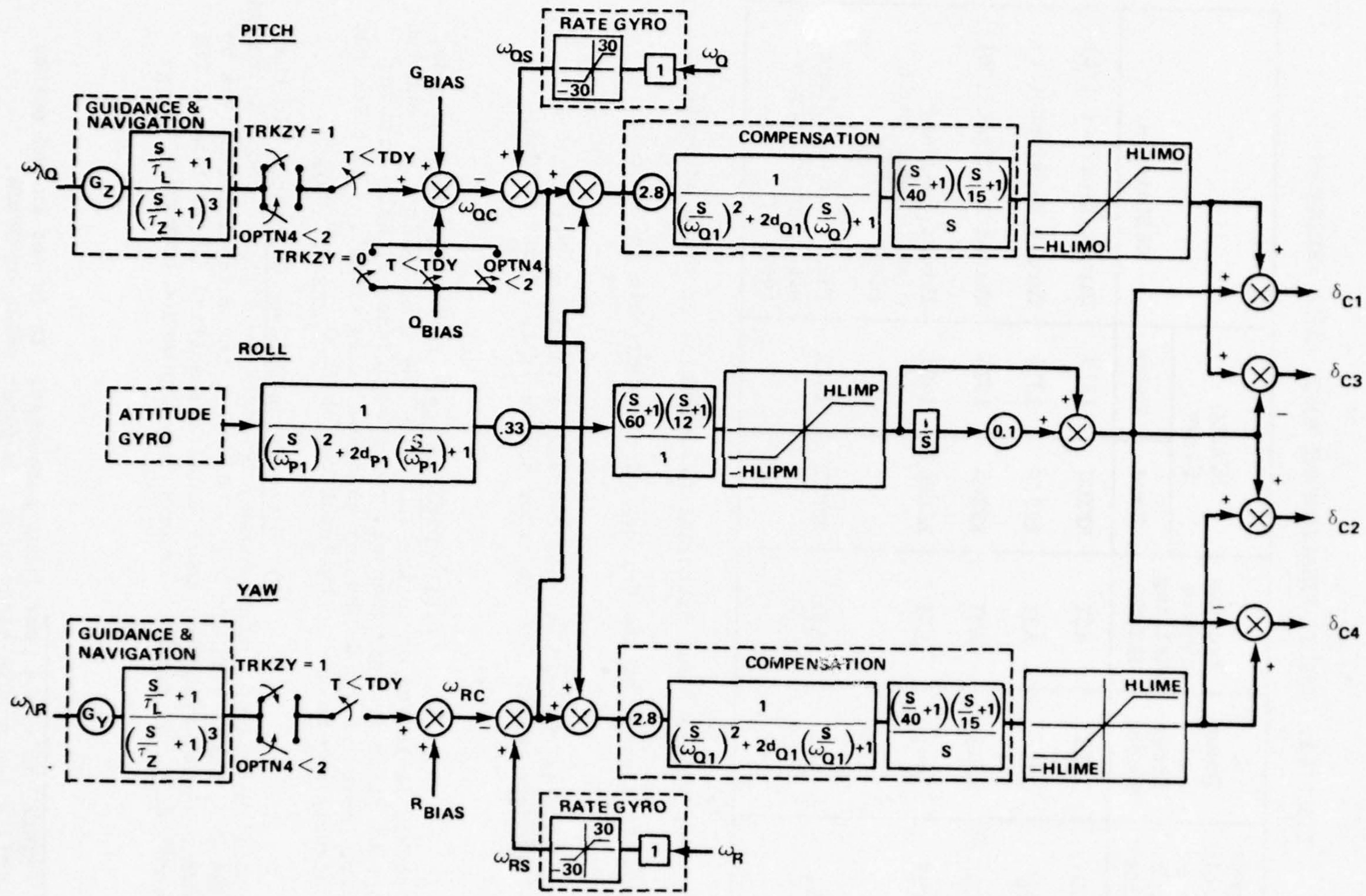


Figure 9. Autopilot block diagram.

R_{BIAS}, and the gravity compensation term G_{BIAS} are followed. At TDY seconds, the autopilot begins receiving guidance signals and normal terminal homing is in effect.

(3) Indirect Fire. If the seeker is in the indirect fire or caged mode (OPTN4 = 2, TRKZY = 0), then a preprogrammed flight profile is executed by using the Q_{BIAS} and R_{BIAS} terms to command pitch and yaw maneuvers. Following acquisition, the seeker is uncaged (TRKZY is set to 1 in the seeker module), Q_{BIAS} is removed and normal terminal homing is in effect.

b. Equations

The first function of the autopilot is to perform appropriate guidance switching and signal shaping. If the seeker is in the direct fire mode (OPTN4 $<$ 1, TRKZY = 1), the seeker output signals are smoothed and shaped by a lead-lag filter with one zero at τ_L and triple pole at τ_Y for yaw and τ_Z for pitch. Gravity effects are continuously compensated for by the addition of a G_{BIAS} term.

The commanded rate signals (ω_{QC} and ω_{RC}) are differenced with the sensed rate (ω_{QS} and ω_{RS}), the feedback signal. The resulting error signals are appropriately summed and differenced to produce the components in the missile's pitch and yaw axes. These signals are compensated by a lead-lag filter with real zeros at 40 and 15 rad/sec, and a complex pole pair with natural frequency ω_{Q1} and damping ratio d_{Q1}. Lastly, the signals are limited to keep the actuators from hitting their stops.

The roll control system attempts to maintain a zero roll attitude via a similar filter to that above with zeros at 60 and 12 rad/sec and poles at natural frequency ω_{P1} and damping d_{P1}. The pitch-roll and yaw-roll signals are summed and differenced in order to produce the appropriate reactions with the four actuators.

c. Initialization

The autopilot initialization subroutine, C1I, moves the indices of the C-array which contains derivatives utilized in the autopilot module into the array IPL(I). The array IPL(I) is used to point the numerical integration logic to the elements of the C-array which are to be numerically integrated.

C4I initializes the filters and integrators of the autopilot module. All initial conditions are set to zero.

C4I also contains the logic for randomizing autopilot error sources. These error sources are described in Section III.B.4.d.

d. Random Error Sources

(1) Pitch and Yaw Errors. The autopilot rate gyros can produce errors that perturb and bias the autopilot rate loops and degrade the sensitivity of the autopilot. Therefore, the primary errors sources of these rates gyros are included. Gyro errors (or more correctly, gyro error torques) can arise from a variety of different sources and are usually expressed as equivalent gyro drift rates.

Constant gyro drift rates result from uncompensated bias torques, L_ϵ, and their magnitude is usually a measure of the gyro quality. Acceleration sensitivity is primarily a function of the mass unbalance about the gyro output axis, i.e., the center of mass not coincident with the output axis. Linear accelerations, A, normal to the output axis produce gyro drift rates proportional to the accelerations.

The last gyro error source to be considered is a characteristic due to the inertia of the gyro float assembly. Angular accelerations about the output axis, $\dot{\omega}_{OA}$, cause gyro pickoff angle errors, which in turn torque the gyro through the electronic caging loop, resulting in a gyro drift rate. Thus, the total gyro error rate is

$$\omega_\epsilon = \frac{L_\epsilon}{H} + \frac{P}{H} A + \frac{J_{OA}}{H} \dot{\omega}_{OA} ,$$

where H is the angular momentum of the rotor, P is the pendulosity, and J_{OA} is the moment of inertia of the floated assembly about its output axis.

The autopilot has two stabilizing rate gyros mounted to sense inertial rates in the pitch and yaw axes. These rate gyros are mounted such that their output axes are aligned with the platform roll axis. Hence, the error rate for the pitch gyro is

$$\omega_{\epsilon Q} = K_{BQ} + K_{PQ} A + K_{OAQ} \dot{\omega}_P ,$$

and for the yaw gyro

$$\omega_{\epsilon R} = K_{BR} + K_{PR} A + K_{OAR} \dot{\omega}_P .$$

The coefficients are user specified by their distribution functions. Since the gyro pendulosity, K_p, has an equal likelihood of occurring anywhere about the gyro output axis, its location is picked from a uniform distribution prior to each run.

(2) Roll Errors. Errors relating to the roll attitude gyro are uncaging errors at launch and drift. These error sources are described in Section III.B.6.d and modeled in subroutine G5.

e. Input/Output Variables and Cross Reference of C-Array

Tables 13, 14, and 15 present the input/output variables and cross reference of C-array for module C1.

f. Monte Carlo Input Variables

The variables associated with the Monte Carlo operation of the autopilot are given in Table 16. The mean values of these variables are input by 3-cards, and the probability distributions are input by 8-cards.

5. C4 - Actuator Module

a. Functional Description

The actuator system utilizes four independently controlled, pneumatically powered servos to position for four movable tail fins. Four commanded actuator fin position signals from the autopilot are summed with the negative feedback signals from the fin position potentiometers on the actuator mechanism. The resulting signals are used to pulse width modulate constant amplitude square wave signals. These signals control the on-off state of solenoid valves which are contained in the pneumatic system between the cold gas pressure source and the servos. An actuator position loop block diagram is depicted in Figure 10.

b. Equations

The actuator system shown in Figure 10 was reduced to the simple first order transfer function shown in Figure 11.

The 6 DOF simulation program actuator model is shown in Figure 12. This model is identical to that of Figure 11, with the exception of the rate and position limiters. As long as actuator operation is not saturated, the two models are identical.

TABLE 13. INPUT FROM DATA CARDS - MODULE C1

Fortran Symbol	Symbol Used in Text	C Index	Definition
TDY	TDY	866	Minimum time before trajectory pitch program will be switched to terminal homing guidance (sec)
GBIAS	G_{BIAS}	854	Gravity bias program (deg/sec)
HLIMO	H_{LIMO}	850	Pitch command limit (deg)
HLIME	H_{LIME}	851	Yaw command limit (deg)
QBIAS	Q_{BIAS}	852	Pitch rate-command bias (deg/sec)
RBIAS	R_{BIAS}	853	Yaw rate-command bias (deg/sec)
GZ	G_Z	867	Pitch navigation guidance filter gain
GY	G_Y	855	Yaw navigation guidance filter gain
WP1	W_{P1}	861	Complex pole of roll control filter (rad/sec)
DP1	d_{P1}	862	Damping coefficient of roll control filter
TAUZ	τ_Z	863	Pitch navigation filter pole (rad/sec)
TAUY	τ_Y	864	Yaw navigation filter pole (rad/sec)
HLIMP	H_{LIMP}	865	Roll command limit (deg)
WQ1	ω_{Q1}	871	Pitch and yaw compensation filter complex pole (rad/sec)
DQ1	d_{Q1}	872	Pitch and yaw compensation filter damping coefficient
TAUL	τ_L	877	Pitch and yaw navigation guidance filter zero (rad/sec)
OPTN4	OPTN4	3504	Fire control switch: 1 - direct fire 2 - indirect fire

TABLE 14. INPUTS FROM OTHER MODULES - MODULE C1

Fortran Symbol	Symbol Used in Text	C Index	Definition
EZ	ω_Z	403	Seeker output - pitch axis (deg/sec)
EY	ω_Y	407	Seeker output - yaw axis (deg/sec)
BPH1	Φ_1	353	Missile roll attitude from roll gyro (deg).
WPD	$\dot{\omega}_P$	1736	Missile roll acceleration (deg/sec^2)
ANGY	A	1677	Translational acceleration along Y_B-axis (g)
ANGZ	A	1678	Translational acceleration along Z_B-axis (g).
AKBQ	K_{BQ}	829	Pitch gimbal drift rate (deg/sec)
AKBR	K_{BR}	830	Yaw gimbal drift rate (deg/sec)
AKPQ	K_{PQ}	833	Pitch gimbal pendulosity coefficient (deg/sec/g)
AKPR	K_{PR}	834	Yaw gimbal drift rate (deg/sec/g)
AKOAQ	K_{OAQ}	837	Pitch gimbal output axis/roll coupling coefficient (sec)
AKOAR	K_{OAR}	838	Yaw gimbal output axis/roll coupling coefficient (sec)
TRKZY	TRKZY	464	Target acquisition switch: 0 - not acquired 1 - acquired
WQ	ω_Q	1743	Missile pitch rate (deg/sec)
WR	ω_R	1747	Missile yaw rate (deg/sec)
T	T	2000	Flight time (sec)

TABLE 15. OUTPUTS - MODULE C1

Fortran Symbol	Symbol Used in Text	C Index	Definition
BDELTC(1)	δ_{c1}	856	Commanded position, fin No. 1
BDELTC(2)	δ_{c2}	857	Commanded position, fin No. 2
BDELTC(3)	δ_{c3}	858	Commanded position, fin No. 3
BDELTC(4)	δ_{c4}	859	Commanded position, fin No. 4

TABLE 16. MONTE CARLO INPUT - MODULE C1

Program Variable Name of Error Source	C Index of Error Source	Program Module Calling MCARLO	MCARLO Flag*		Definition
			Name	Index	
AKBQ	829	C1I		829	Pitch gimbal drift rate (deg/sec)
AKBR	830	C1I		830	Yaw gimbal drift rate (deg/sec)
AKPQ	833	C1I		833	Pitch gimbal pendulosity coefficient (deg/sec/g)
AKPR	834	C1I		834	Yaw gimbal drift rate (deg/sec/g)
AKOAQ	837	C1I		837	Pitch gimbal output axis/roll coupling coefficient (sec)
AKOAR	838	C1I		838	Yaw gimbal output axis/roll coupling coefficient (sec)

*MCARLO is flagged by the C-index of this variable in the calling module.

When MCARLO is flagged by this C-index, a random number will be returned from MCARLO for the error source in the first column.

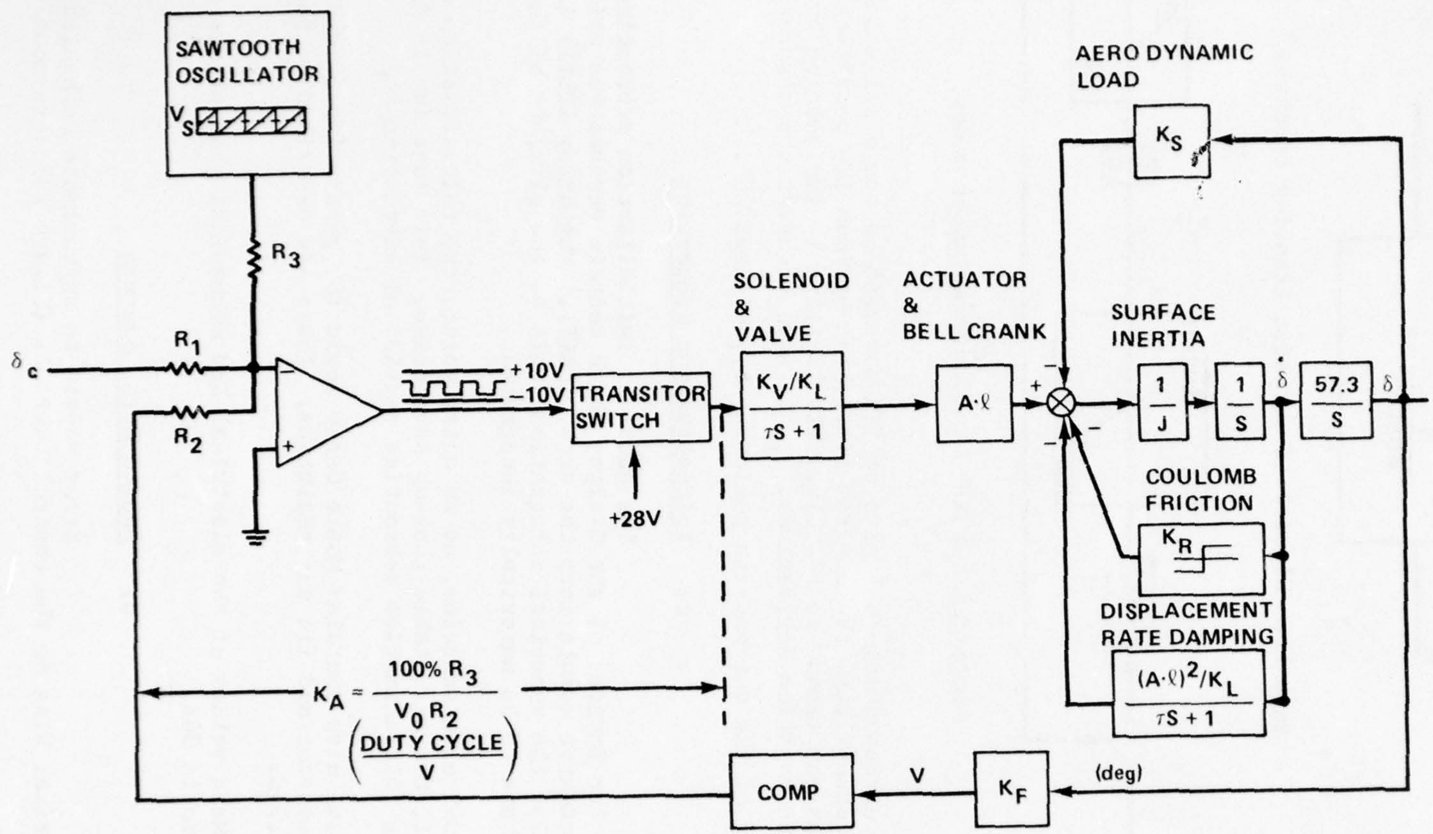


Figure 10. Actuator position loop.

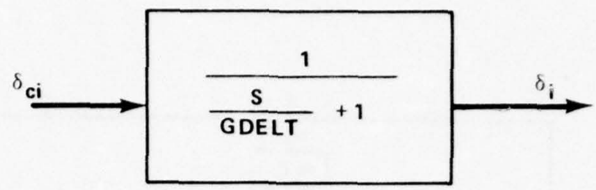


Figure 11. Linearized actuator transfer function.

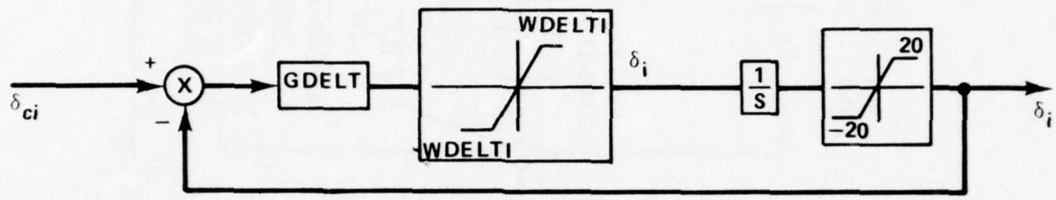


Figure 12. 6 DOF simulation actuator model.

Corresponding to limits of fin movement on the missile and torque motor capability, the program limits the maximum fin positions to ±20° and maximum torque to ±WDELTL. Fin limiting is implemented by setting the fin position derivatives, $\dot{\delta}_i$, to zero whenever the absolute value of any of the current fin position, δ_i, exceeds 20°.

c. Initialization Subroutine

The actuator initialization subroutine, C4I, moves the indices of the C-array which contain derivatives utilized in the actuator module into the array IPL(I). The array IPL(I) is used to point the numerical integration logic to the elements of the C-array which are to be numerically integrated.

C4I also contains, as an entry point, the initialization routine for A1, the aero table look-up subroutine. This function is discussed in the initialization subroutine section of subroutine A1.

C4I also contains Monte Carlo logic for generation of random values for actuator and fin uncertainties. These are described in Section III.B.5.d.

Mean values of the electrical and mechanical bias errors are set to zero in C4I.

d. Random Error Sources

Error models to approximate mechanical and electrical bias on the control surfaces (Figure 13) were modeled

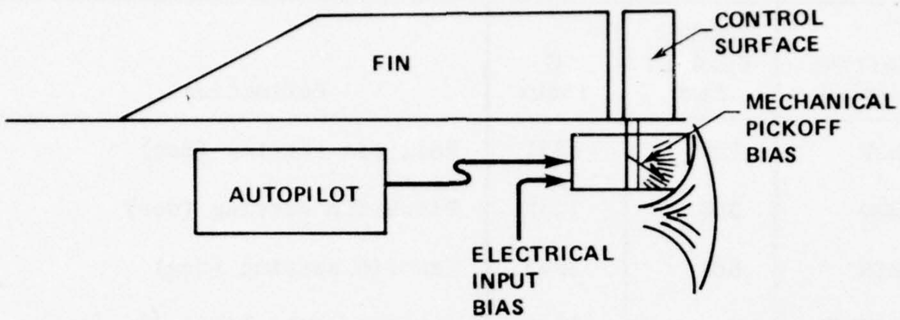


Figure 13. Control surface bias.

independently. Both the electrical and mechanical bias errors were assumed to be angular errors in the combined fin setting of roll, pitch, and/or yaw. Module C4I initializes the individual fin settings at time = 0 from input data cards for mean values of roll (BDP), pitch (BDQ), yaw (BDR), and Monte Carlo error values for the mechanical and electrical bias. The combined error values are:

DELTB = FELECB + FMECHB (roll setting error) .

DELTQB = FELECQB + FMECHQB (pitch setting error) .

DELTRB = FELECRB + FMECHRB (yaw setting error) .

The individual fin settings, including the electrical and mechanical bias, are:

BDELT1 = -(BDP + DELTB) + (BDQ + DELTQB) - (BDR + DELTRB) .

BDELT2 = -(BDP + DELTB) + (BDQ + DELTQB) + (BDR + DELTRB) .

BDELT3 = (BDP + DELTB) + (BDQ + DELTQB) - (BDR + DELTRB) .

BDELT4 = (BDP + DELTB) + (BDQ + DELTQB) + (BDR + DELTRB) .

e. Input/Output Variables and Cross Reference of C-Array

Tables 17, 18, and 19 present the input/output variables and cross reference of C-array for module C4.

f. Monte Carlo Input Variables and Cross Reference of C-Array

Table 20 presents the Monte Carlo input variables and cross reference of C-array for module C4.

TABLE 17. INPUT FROM DATA CARDS - MODULE C4

Fortran Symbol	Symbol Used in Text	C Index	Definition
BDP	BDP	1231	Roll fin setting (deg)
BDQ	BDQ	1232	Pitch fin setting (deg)
BDR	BDR	1233	Yaw fin setting (deg)
WDELTL	W_{DELTL}	1143	Actuator rate limit (deg/sec)
GDELT	G_{DELT}	1144	Actuator pole (rad/sec)

TABLE 18. INPUT FROM OTHER MODULES - MODULE C4

Fortran Symbol	Symbol Used in Text	C Index	Definition
BDELTC(1)	δ_{c1}	856	Commanded fin position from autopilot, fin No. 1
BDELTC(2)	δ_{c2}	857	Commanded fin position from autopilot, fin No. 2
BDELTC(3)	δ_{c3}	858	Commanded fin position from autopilot, fin No. 3
BDELTC(4)	δ_{c4}	859	Commanded fin position from autopilot, fin No. 4
DELTB	DELTB	1254	Monte Carlo fin setting error in roll (deg)
DELTQB	DELTQB	1255	Monte Carlo fin setting error in pitch (deg)
DELTRB	DELTRB	1256	Monte Carlo fin setting error in yaw (deg)

TABLE 19. OUTPUTS - MODULE C4

Fortran Symbol	Symbol Used in Text	C Index	Definition
BDELT(1)	δ_1	1103	Actual fin position, fin No. 1
BDELT(2)	δ_2	1107	Actual fin position, fin No. 2
BDELT(3)	δ_3	1111	Actual fin position, fin No. 3
BDELT(4)	δ_4	1115	Actual fin position, fin No. 4

TABLE 20. MONTE CARLO INPUT - MODULE C4

Program Variable Name of Error Source	C Index of Error Source	Program Module Calling MCARLO	MCARLO Flag*		Definition
			Name	Index	
DELTB	1254	C4I	FELECB	1101	Electrical bias in roll (deg)
DELTB	1254	C4I	FMECHB	1106	Mechanical bias in roll (deg)
DELTQB	1255	C4I	FELECQB	1102	Electrical bias in pitch (deg)
DELTQB	1255	C4I	FMECHQB	1109	Mechanical bias in pitch (deg)
DELTRB	1256	C4I	FELECRB	1105	Electrical bias in yaw (deg)
DELTRB	1256	C4I	FMECHRB	1110	Mechanical bias in yaw (deg)

*MCARLO is flagged by the C-index of this variable in the calling module.

When MCARLO is flagged by this C-index, a random number will be returned from MCARLO for the error source in the first column.

6. D1 - Translational Dynamics Module

a. Functional Description

The translation dynamics module calculates translational accelerations of the missile in both the earth and body coordinate systems, and moves the missile acceleration components to the velocity integrator locations in the C-array.

The missile velocity components obtained on the previous integration step are moved to the position integrator locations in the C-array. Missile g acceleration in body axes are obtained for information purposes. If the target motion option is selected on input (OPTARG > 0), target motion derivatives are also calculated based upon input values of linear acceleration and a turning term. The target acceleration and velocity components are moved to the target velocity and position locations in the C-array.

b. Equations

The following paragraphs give missile related and target motion equations.

(1) Missile Related Equations.

a) Total acceleration in body axes -

$$\begin{bmatrix} AXBA \\ AYBA \\ AZBA \end{bmatrix}_B = \frac{1}{DMASS} \begin{bmatrix} FXBA \\ FYBA \\ FZBA \end{bmatrix}_B$$

where FXBA, FYBA, and FZBA are calculated in the forces and moments module (A2) and represent the sum of the aerodynamic and thrust forces, and DMASS is the instantaneous total vehicle mass calculated in the engine module (A3).

b) Total acceleration in earth axes -

$$\begin{bmatrix} AXE \\ AYE \\ AZE \end{bmatrix}_E = M^T \begin{bmatrix} AXBA \\ AYBA \\ AZBA \end{bmatrix}_B$$

where M^T is the transpose of the earth-to-body transformation matrix, calculated in the rotational dynamics module (D2).

c) Earth axes velocity integrator values -

$$\begin{bmatrix} VXED \\ VYED \\ VZED \end{bmatrix} = \begin{bmatrix} AXE \\ AYE \\ AZE + AGRAV \end{bmatrix}$$

where AGRAV is the acceleration due to gravity. The "velocity integrator" locations in the C-array (equivalenced to VXED, VYED, and VZED in the translation dynamics module (D1I) are the actual C locations which are used in the numerical integration routine AMRK.

d) Body axes velocity integrator values -

$$\begin{bmatrix} VDXB \\ VDYB \\ VDZB \end{bmatrix}_B = M \begin{bmatrix} VXED \\ VYED \\ VZED \end{bmatrix}_E .$$

e) g-acceleration in body axes -

$$\begin{bmatrix} ANGX \\ ANGY \\ ANGZ \end{bmatrix}_B = \frac{1}{g} \begin{bmatrix} VDXB \\ VDYB \\ VDZB \end{bmatrix}_B .$$

The body axes accelerations are calculated for information, and can be optionally printed.

f) Earth axes position integrator values -

$$\begin{bmatrix} RXED \\ RYED \\ RZED \end{bmatrix}_B = \begin{bmatrix} VXE \\ VYE \\ VZE \end{bmatrix}_B .$$

(2) Target Motion Equations. Several input parameters are available for specifying target motion during the simulation. One, ATHRST, represents simply the magnitude of the target acceleration vector. A second parameter, ATURNT, represents one variable in the calculation of the rate of change of the earth plane azimuth angle ($\dot{\psi}$) of the velocity vector, where the second variable in the calculation is the instantaneous magnitude of the velocity vector itself. The initial azimuth angle (ψ_0) can be input, as can an elevation angle (γ_0), where the sign convention of these angles is shown in Figure 14. A summary of the kinds of target motion that can be achieved with the input target motion parameters is presented in Table 21.

TABLE 21. TARGET MOTION SUMMARY

ATHRST	ATURNT	VTARG	γ	ψ	Target Motion*
0	0	0	-	-	None
0	0	> 0	γ_0	ψ_0	Constant velocity of target away from origin in the direction specified by (γ_0, ψ_0).
> 0	0	V_0	γ_0	ψ_0	Constant acceleration of target away from origin in the direction (γ_0, ψ_0), with initial velocity V_0.
0	> 0	$V_0 > 0$	γ_0	ψ_0	Constant magnitude of velocity, initially in the direction of (γ_0, ψ_0), with direction of velocity vector changing at a constant rate determined by ATURNT and V_0.
> 0	> 0	V_0	γ_0	ψ_0	Constantly accelerating target away from origin in initial direction of (γ_0, ψ_0), but with increasing (at a decreasing rate) with time.

*Note all of the motions listed in Table 16 will automatically be initiated from the origin of the earth axes whenever OPTN2 > 0, because subroutine D1I sets the target position coordinates to zero. Also, some combinations are not shown because they would not result in target motion due to the manner in which the equations are written. Thus, for example, the combination of ATHRST = 0, ATURNT > 0, VTARG = 0, (γ and ψ arbitrary) would result in no target motion.

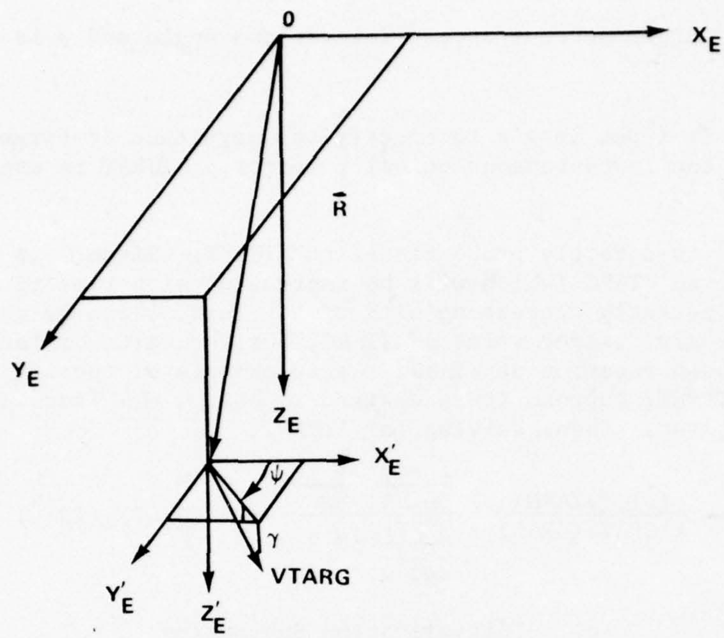


Figure 14. Target motion velocity vector*.

VTARGD = (ATHRST)(AGRAV),

where VTARG is the target velocity integrator position in the C-array, and ATHRST is the input value of target acceleration in g's.

$$\dot{\psi} = \frac{\text{ATURNT}}{\text{VTARGD}} \text{(AGRAV)(CRAD)}$$

where $\dot{\psi}$ is the target velocity vector azimuth angle (Figure 14), ATURNT is an input value (with units of g's) which partially determine the rate of change of the azimuth angle.

The components of the target velocity vector in the earth system are as follows:

$$\text{VTXE} = \text{VTARG} \cos(\gamma_0) \cos(\psi)$$

$$\text{VTYE} = \text{VTARG} \cos(\gamma_0) \sin(\psi)$$

$$\text{VTZE} = \text{VTARG} \sin(\gamma_0)$$

---

*NOTE: A system ($X_{E'}$, $Y_{E'}$, $Z_{E'}$), parallel to the earth axis system, has been defined at the terminal point of the radius vector to emphasize the face that γ and ψ specify the instantaneous direction of the target velocity vector rather than the radius vector.

where γ_0 is target descent/ascent (elevation) angle and ψ is target azimuth.

ATHRST is input in g's to specify the magnitude of target acceleration along the instantaneous velocity vector. ATURNT is used in the equation for $\dot{\psi}$.

Thus, $\dot{\psi}$ is directly proportional to ATURNT. Since $\dot{\psi}$ is inversely proportional to VTARG (which will be increasing with time if ATHRST > 0) $\dot{\psi}$ will be constantly decreasing with time. Thus, $\dot{\psi}$ can be controlled on input for any desired value of VTARG, but the value of for all other times will be a function of VTARG. As an example of specifying an input value for ATURNT, suppose it is desired to have $\dot{\psi} = 1°/\text{sec}$ when VTARG = 1 ft/sec. Then, solving for ATURNT,

$$\text{ATURNT} = \frac{(\dot{\psi})\ (\text{VTARG})}{(\text{AGRAV})(\text{CRAD})} = \frac{\dfrac{1\ \text{deg}}{\text{sec}}\ \dfrac{1\ \text{ft}}{\text{sec}}}{\dfrac{32\ \text{ft}}{\text{sec}^2\ \text{g}}\ 57.3\ \text{deg}} \approx (5.47)\ (10^{-4})\ \text{g} \quad .$$

c. Initialization Subroutine

The translational dynamics initialization subroutine (D1I) calculates initial missile position and velocity components according to one of seven combinations of input option switches OPTN2 and OPTN4. Table 22 depicts the input variables required for each option, where the variables are defined as:

RXE, RYE, RZE, VXE, VYE, VZE	Initial missile position and velocity coordinates in earth axes system.
BPSIO, BTHTO, BPHIO	Euler angles orienting body axes with respect to the earth axes (see Figure C-1 in Appendix C).
BTHTG, BPSIG	Initial gimbal angles in pitch and yaw, respectively.
RSLANT	Initial slant range from missile to target.

TABLE 22. INPUT DATA OPTIONS FOR INITIAL VALUES

	Unrestricted Inputs	Restricted Inputs					
		No Rail Dynamics		Rail Dynamics Included			
		Direct Fire		Direct Fire		Indirect Fire	
OPTN4	0	0	0	1	1	2	2
OPTN2	0	1	2	1	2	1	2
RXE	X	I	X	I	X	I	X
RYE	X	0	0	0	0	0	0
RZE	X	I	X	I	X	I	X
VXE	X	I	I	I	I	I	I
VYE	X	I	I	I	I	I	I
VZE	X	I	I	I	I	I	I
RTXE	X	0	0	0	0	0	0
RTYE	X	0	0	0	0	0	0
RTZE	X	0	0	0	0	0	0
BPSIO	X	I	I	X	X	X	X
BTHTO	X	I	I	X	X	X	X
BPHIO	X	0	0	0	0	0	0
BTHTG	X	X	X	I	I	X	X
BPSIG	X	X	X	I	I	X	X
RSLANT		X	I	X	I	X	I
BSLOV		X		X		X	
VWXE		X	X	X	X	X	X
VWYE		X	X	X	X	X	X
VWZE		X	X	X	X	X	X
(VMACH / VMWTE)*		X	X	X	X	X	X

X - denotes variables that must be specified by input data.
I - denotes variables that are computed internally.
0 - denotes variables that are either set to zero initially or will be computed as zero.

*Input YMACH if OPTN6 = 0; input VMWTE if OPTN6 = 1.

BLOSV	Angle between line-of-sight and earth plane. (Sign convention: BSLOV > 0 when line-of-sight is above the earth plane.)
VWXE VWYE VWZE	Wind velocity components in earth axes.
VMACH	Initial missile Mach number.

d. Random Error Sources

D1I contains three Monte Carlo error sources. Only one of these error sources, missile launch attitude, is directly related to the function of D1, that is, translational dynamics computation. The other two, roll gyro attitude error and roll gyro drift rates appear here because the error values are required in the initialization of the transformation matrix $[A_0]$ and the initial position of the roll gyro (X_{BO1}, Y_{BO1}, Y_{BO}) that are used in subroutine G5.

(1) Missile Launch Attitude. Missile launch attitude, illustrated in Figure 15 is modeled in the initialization module D1I. The attitude angles BTHTO, TPHIO, and BPSIO are the mean error sources for attitude randomization. BTHTO and BPSIO mean values are input quantities, while the mean value of BPHIO is set to zero in D1I.

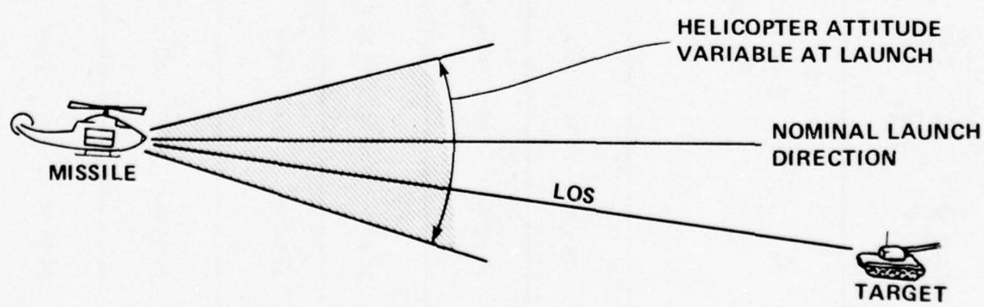


Figure 15. Missile launch attitude.

(2) Autopilot Gyros. Autopilot roll attitude gyro errors are made up of an inertial misalignment at uncaging and drift. The inertial misalignment due to uncertainties in helicopter attitude also cause missile launch attitude errors (Figure 16); therefore, it should be remembered that the probability distributions for these two error sources (launch attitude and gyro misalignment) should be the same.

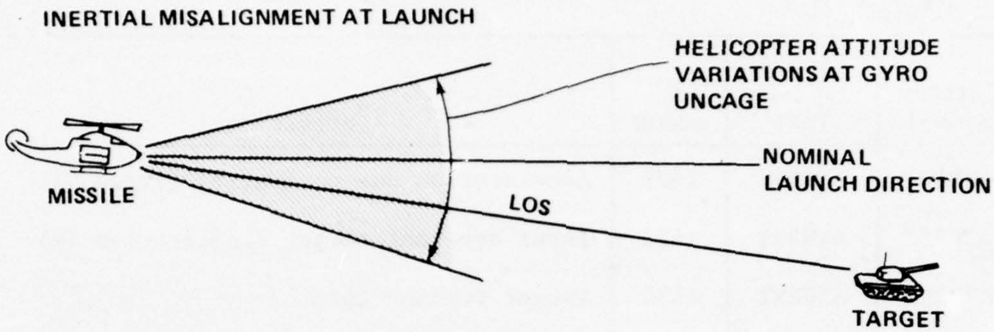


Figure 16. Autopilot gyro uncertainties.

The mean error sources for the autopilot gyro misalignment angles are the missile launch attitude angles BPHI0 and BPSI0. The mean values of these launch attitude angles are set by input data card. The mean error sources for the gyro drift components are P_1 and R_1. The mean values of these variables are set to zero in module D1I.

Gyro drift has two components due to the construction of the autopilot gyro. The gyro is a 2 DOF gyro; thus, it rotates independently about two axes. The rotational axes are yaw (R_1) and roll (P_1). The dynamical equations for gyro drift rate are presented in Section III.B.11.c.

e. Input/Output Variables and Cross Reference of C-Array

Tables 23, 24, and 25 present the input/output variables and cross reference of C-array for module D1.

f. Monte Carlo Input Variables and Cross Reference of C-Array

The Monte Carlo input variables and cross reference of C-array of module D1 is presented in Table 26.

7. D2 - Rotational Dynamics Module

a. Functional Description

The rotational dynamics module calculates the numerical values for the derivatives of the vehicle rotational rates (ω_P, ω_Q, and ω_R), and the elements (C_{ij}, i,j = 1, 2, 3) of the earth-to-body axis transformation matrix, M.

TABLE 23. INPUT FROM DATA CARDS - MODULE D1

Fortran Symbol	Symbol Used in Text	C Index	Definition
AGRAV	AGRAV	1627	Acceleration due to gravity (ft/sec^2)
ATHRST	ATHRST	1629	Input constant target acceleration (g)
ATURNT	ATURNT	1630	Target turning term
BGAMT	γ	1631	
OPTARG	OPTARG	1639	Target motion option switch (OPTARG > 0 for target motion)
CRAD	CRAD	1751	Radians to degrees conversion
BPSIT	γ	1647	Target azimuth
RXE RYE RZE	RXE RYE RZE	1615 1619 1620	Components of missile position in earth fixed coordinate system (ft)
VXE VYE VZE	VXE VYE VZE	1603 1607 1611	Components of missile velocity in earth fixed coordinate system (ft/sec)
BPSIO	BPSIO	1754	Autopilot gyro yaw angle (deg)
BTHTO	BTHTO	1753	Autopilot gyro pitch angle (deg)
BPHIO	BPHIO	1752	Autopilot gyro roll angle (deg)
RSLANT	RSLANT	1667	Initial slant range from missile to target (ft)
BSLOV	BSLOV	1666	Angle between line-of-sight and earth plane (Sign convention: BSLOV > 0 when line-of-sight is above earth plane) (deg)
VWXE VWYE VWZE	VWXE VWYE VWZE	100 101 102	Wind velocity components in earth axes (ft/sec)

TABLE 24. INPUT FROM OTHER MODULES - MODULE D1

Fortran Symbol	Symbol Used in Text	C Index	Definition
FXBA	FXBA	1300	Components of total forces acting on missile in body coordinate system (lb)
FYBA	FYBA	1301	
FZBA	FZBA	1302	
CFA11	CFA11	1703	Elements of the earth-to-body transformation matrix, M
CFA12	CFA12	1707	
CFA13	CFA13	1711	
CFA21	CFA21	1715	
CFA22	CFA22	1719	
CFA23	CFA23	1723	
CFA31	CFA31	1727	
CFA32	CFA32	1731	
CFA33	CFA33	1735	

TABLE 25. OUTPUT - MODULE D1

Fortran Symbol	Symbol Used in Text	C Index	Definition
VXE	VXE	1603	Components of missile velocity in earth fixed coordinate system (ft/sec)
VYE	VYE	1607	
VZE	VZE	1611	
RXE Q	RXE	1615	Components of missile position in earth fixed coordinate system (ft)
RYE	RYE	1619	
RZE	RZE	1620	
AXBA	AXBA	1624	Components of total missile acceleration in the body axes (ft/sec^2)
AYBA	AYBA	1625	
AZBA	AZBA	1626	
VTXE	VTXE	1660	Components of target velocity in the earth system (ft/sec)
VTYE	VTYE	1661	
VTZE	VTZE	1662	
VDXB	VDXB	1663	Body axes acceleration (ft/sec^2)
VDYB	VDYB	1664	
VDZB	VDZB	1665	
ANGX	ANGX	1676	g-accelerations in body axes
ANGY	ANGY	1677	
ANGZ	ANGZ	1678	

TABLE 26. MONTE CARLO INPUTS - MODULE D1

Program Variable Name of Error Source	C Index of Error Source	Program Module Calling MCARLO	MCARLO Flag*		Definition
			Name	Index	
BTHTO	1753	D1I	BTHTO	1753	Initial pitch angle (deg)
BPHIO	1752	D1I	BPH1ER	360	Autopilot gyro roll error (deg)
BPSIO	1754	D1I	BPS1ER	362	Autopilot gyro yaw error (deg)
P1	1764	D1I	P1	1764	Roll rate about gyro inner gimbal (deg/sec)
R1	1765	D1I	R1	1765	Yaw rate about gyro outer gimbal (deg/sec)

*MCARLO is flagged by the C-index of this variable in the calling module.

When MCARLO is flagged by this C-index, a random number will be returned from MCARLO for the error source in the first column.

b. Equations

The rotational derivatives of the vehicle are calculated from values of the respective moments [calculated in the forces and moments module (A2)] and input values of the moments of inertia. The equations are:

$$\dot{\omega}_P = \frac{M_X}{I_{XX}} \text{ (roll)}$$

$$\dot{\omega}_Q = \frac{M_Y + (I_Z - I_X)(\omega_P)(\omega_R)}{I_{YY}} \text{ (pitch)}$$

$$\dot{\omega}_R = \frac{M_Z + (I_X - I_Y)(\omega_P)(\omega_Q)}{I_{ZZ}} \text{ (yaw)}$$

where M_α, $\alpha = X, Y, Z$, denotes the moment of force about X, Y, and Z body axes, respectively; $I_{\alpha\alpha}$, $\alpha = X, Y, Z$, denotes the moment of inertia about the X, Y, and Z body axes, respectively; and ω_P, ω_Q, and ω_R are in rad/sec.*

If OPTN3 > 0 [input roll option switch, C(3503)], the calculation of $\dot{\omega}_P$ is not accomplished, and missile roll is not simulated (a constant roll rate is maintained).

The derivatives ($\dot{C}_{ij}$, i,j = 1, 2, 3) of the elements of the earth to body transformation matrix, M, are calculated using the following equations:

$$\dot{C}_{11} = (C_{21})(\omega_R) - (C_{31})(\omega_Q) \quad .$$

$$\dot{C}_{12} = (C_{22})(\omega_R) - (C_{32})(\omega_Q) \quad .$$

$$\dot{C}_{13} = (C_{23})(\omega_R) - (C_{33})(\omega_Q) \quad .$$

$$\dot{C}_{21} = (C_{31})(\omega_P) - (C_{11})(\omega_R) \quad .$$

$$\dot{C}_{22} = (C_{32})(\omega_P) - (C_{12})(\omega_R) \quad .$$

---

*Note that in the 6 DOF simulation program, ω_P, ω_Q, and ω_R are in deg/sec, so the factor CRAD = 57.295778 appears where appropriate.

$$\dot{C}_{23} = (C_{33})\ (\omega_P) - (C_{13})\ (\omega_R) \quad .$$

$$\dot{C}_{31} = (C_{11})\ (\omega_Q) - (C_{21})\ (\omega_P) \quad .$$

$$\dot{C}_{32} = (C_{12})\ (\omega_Q) - (C_{22})\ (\omega_P) \quad .$$

$$\dot{C}_{33} = (C_{13})\ (\omega_Q) - (C_{23})\ (\omega_P) \quad .$$

c. Assumptions

The derivation of $\dot{\omega}_P$, $\dot{\omega}_Q$, and $\dot{\omega}_R$ requires the assumptions that (1) the products of inertia (I_{XY}, I_{XZ}, I_{YZ}, etc.) are zero, and (2) the time derivatives of the principal moments of inertia ($\dot{I}_{XX}$, $\dot{I}_{YY}$, $\dot{I}_{ZZ}$) are zero. The point at which these assumptions are required in deriving these equations is discussed in Appendix A.

A derivation of the matrix element derivations, ($\dot{C}_{ij}$), is accomplished in Appendix B. No limiting assumptions, other than that the earth fixed coordinate system is inertial, are required in the derivation.

d. Initialization Subroutines

A rotational dynamics initialization subroutine, (D2I), calculates the initial earth to body axis transformation matrix, M, from the input initial Euler angles ψ, θ, and Φ, which are defined as follows:

1) A positive rotation (toward Y_E from X_E) of ψ (degrees) about the Z_E axis, giving a system e' (X', Y', Z').

2) A negative rotation (the X' axis up from the plane of the earth axis system) of θ about the Y' axis, giving a system e''(X'', Y'', Z'').

3) A positive rotation (toward Z'' from Y'') of Φ degrees about the X'' axis, given the body axis system $E_B(X_B, Y_B, Z_B)$.

The angles are depicted in Figure 17 where (X_E, Y_E, Z_E) and (X_B, Y_B, Z_B) represent the earth and body axes, respectively.

The resulting transformation, M, from the earth axis system to the body axis system is given by the following equation.

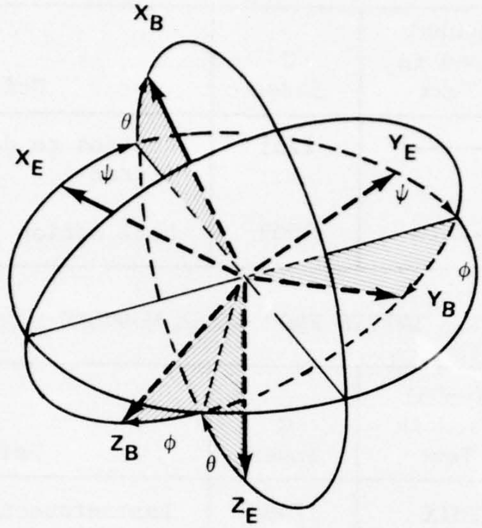


Figure 17. Euler angle geometry.

$$M = \begin{bmatrix} \cos\psi\cos\theta & \sin\psi\cos\theta & -\sin\theta \\ \cos\psi\sin\theta\sin\Phi - \sin\psi\cos\Phi & \cos\psi\cos\Phi + \sin\psi\sin\theta\sin\Phi & \cos\theta\sin\Phi \\ \cos\psi\sin\theta\cos\Phi + \sin\psi\sin\Phi & \sin\psi\sin\theta\cos\Phi - \cos\psi\sin\Phi & \cos\theta\cos\Phi \end{bmatrix}.$$

Thus, a vector $\overline{V}_E$ expressed in the earth axis system is given in the body axis system as $\overline{V}_B = M\overline{V}_E$. The transformation is derived for reference in Appendix C.

e. Input/Output Variables and Cross Reference of C-Array

Tables 27, 28, and 29 present the input/output variables and cross reference of C-array for module D2.

8. G2 - Winds Module

a. Functional Description

Subroutine G2 models the time varying (gusts) component of the winds module. If the Monte Carlo time varying component of the wind has not been selected, then G2 is a dummy routine and nothing

TABLE 27. INPUT FROM DATA CARDS - MODULE D2

Fortran Symbol	Symbol Used in Text	C Index	Definition
CRAD	-----	1751	Radians to degrees conversion factor
OPTN3	-----	3503	Roll option switch

TABLE 28. INPUTS FROM OTHER MODULES - MODULE D2

Fortran Symbol	Symbol Used in Text	C Index	Definition
FMIX FMIY FMIZ	FMIX FMIY FMIZ	1748 1749 1750	Instantaneous values of moments of inertia (slug-ft^2)
FMXBA FMYBA FMZBA	FMXBA FMYBA FMZBA	1303 1304 1305	Components of the total moments of force about the body coordinate system (ft-lb)

is computed. For the deterministic mode or the Monte Carlo steady state mode, the one time wind calculations are made in G2I. The wind velocity components are referenced to the earth fixed coordinate system.

b. Equations

The time varying wind component is simulated by passing white noise through the first order filter shown in Figure 18. The time varying output of the filter is added to the steady state wind component to get the total wind velocity.

The wind gust model contains frequency components that are both a function of distance and time. The time component represents a time varying wind at a fixed point in space while the distance component represents the variation in the steady state component with range. Figure 19 illustrates the nature of the range dependent steady state wind.

The filter constants and the standard deviation of the output are dependent on the missile and quasi-steady state wind velocities and on a parameter referred to as the scale length, L_u. From an

TABLE 29. OUTPUT - MODULE D2

Fortran Symbol	Symbol Used in Text	C Index	Definition
CFA11	C_{11}	1703	Elements of the earth-to-body transformation matrix, M
CFA12	C_{12}	1707	
CFA13	C_{13}	1711	
CFA21	C_{21}	1715	
CFA22	C_{22}	1719	
CFA23	C_{23}	1723	
CFA31	C_{31}	1727	
CFA32	C_{32}	1731	
CFA33	C_{33}	1735	
WP	ω_P	1739	Roll rate about X_B-axis (deg/sec)
WQ	ω_Q	1743	Pitch rate about Y_B-axis (deg/sec)
WR	ω_R	1747	Yaw rate about Z_B-axis (deg/sec)

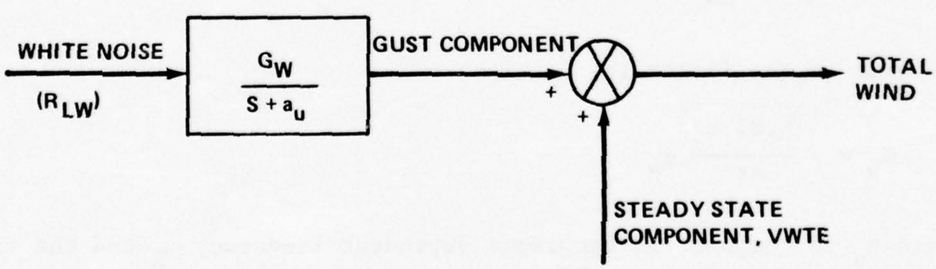


Figure 18. Wind gusts filter.

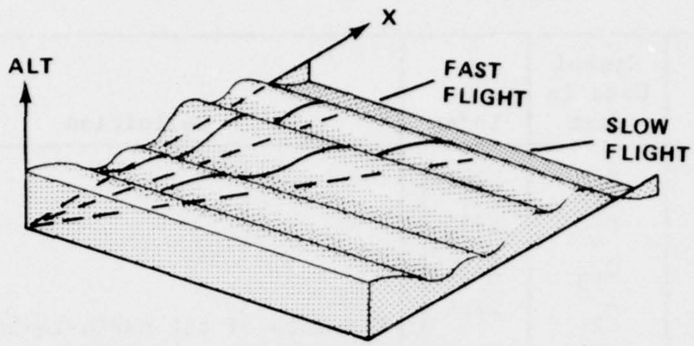


Figure 19. Space dependent wind field model.

examination of the wind profile shown in Figure 19, it can be seen why missile velocity and direction relative to the wind field are important. The velocity and direction determine the frequency at which the crests in the wind field are struck by the missile as it flies downrange. The scale length, L_u, represents roughly the longest distance that two points in the wind field can be separated before correlation between their velocities becomes zero.

The differential equation of the filter is

$$\dot{X} + a_u X = R_{Lw} \quad .$$

The gain of the filter is

$$G_w = \sqrt{\frac{1.89\, a_u}{\Delta t}}\, \sigma_u$$

where a_u is composed of the range dependent frequency ω_R and the time dependent frequency ω_T, or

$$a_u = \omega_R + \omega_T \quad .$$

The range dependent frequency ω_R is

$$\omega_R = \frac{u}{L_u} \quad ,$$

where u is the projection of missile velocity ($\overline{V}_{MSLE}$) onto the wind velocity, or

$$u = \overline{V}_{MSLE} \cdot \frac{\overline{VWTE}}{|\overline{VWTE}|} \quad .$$

The scale length, L_u, (an empirically determined quantity) is

$$L_u = -12.1\ \sigma_u + 475 \quad .$$

The time dependent frequency, ω_T, is

$$\omega_T = \frac{|\overline{VWTE}|}{VWTEM} \quad ,$$

where VWTEM is the mean value of the probability distribution (Figure 20) from which the steady state wind ($\overline{VWTE}$) is initialized for each run of a run set if the steady state wind is to be randomly selected. If however, $\overline{VWTE}$ is not randomly selected, but instead is computed from the standard deviation of the gusts via the equation VWTE = 2.9 σ_u, then

$$\omega_T = 1 \text{ rad/sec} \quad .$$

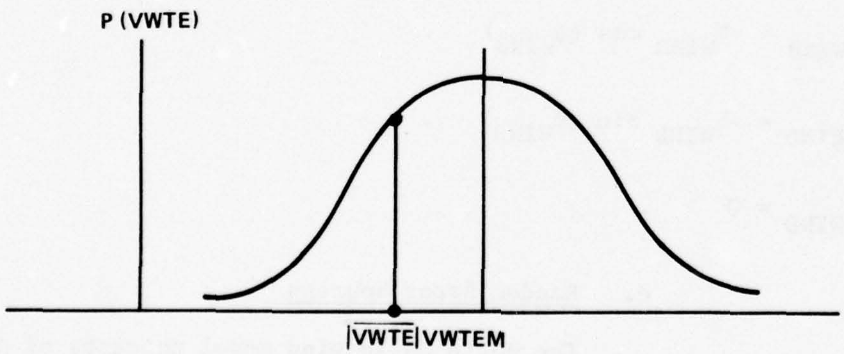


Figure 20. Steady state wind distribution.

The expected standard deviation, σ_u, of the wind gusts model is directly proportional to the steady state wind component $|\overline{VWTE}|$ by

$$\sigma_u \quad \frac{|\overline{VWTE}|}{2.9} \quad .$$

The option to compute σ_u from the previously mentioned equation or the option to compute $|\overline{VWTE}|$ from

$$|\overline{VWTE}| = 2.9\ \sigma_u$$

is left to the user.

c. Initialization Subroutine

The steady state wind magnitude VWTE and direction BPSIW (Figure 21) are modeled in module G2I as Monte Carlo variables. The mean of the steady state wind is the value of VWTE input by type 3 data card, and the mean of the wind direction is the input value of BPSIW input on a type 3 data card. In the deterministic mode, the velocity components of the wind are computed based on input values of wind velocity, V_{WIND}, and wind direction, ψ_{WIND}, as shown in Figure 22. G2I also computes the Monte Carlo initial value of the time series wind gusts.

$$V_{XWIND} = -V_{WIND} \cos (\psi_{WIND}) \quad .$$

$$V_{YWIND} = -V_{WIND} \sin (\psi_{WIND}) \quad .$$

$$V_{ZWIND} = 0 \quad .$$

d. Random Error Sources

The Monte Carlo wind model consists of a steady state wind component and a time varying (gusts) component. Either component of the model may be randomized independently of the other. However, when exercising the time varying model, consideration must be made concerning the relationship between the steady state wind magnitude VWTE and the expected standard deviation SIGU (σ_u) of the time varying component. This relationship was given in Section III.B.8.b. Input combinations of the steady state wind and the time varying wind is given

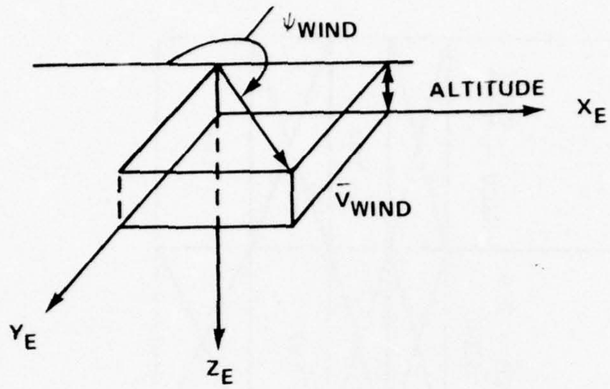


Figure 21. Wind components.

in Table 30. An explanation of each combination follows the table. The type 3 and type 8 input cards referred to in Table 30 are explained in Section IV.A , "Input Card Types."

(1) Monte Carlo Steady State Wind Only. The steady state wind magnitude and direction are randomly selected for each run of the run set from user specified probability distributions. The type 3 card input values of VWTE and BPSIW are the mean values for the probability distributions.

(2) Monte Carlo - Both Steady State and Time Varying Wind. The steady state wind magnitude and direction are randomly selected for each run of the run set from user specified probability distributions. The type 3 card input values of VWTE and BPSIW are the mean values for the probability distributions. The time varying wind component will be randomly generated from MCARLO white noise. The expected standard deviation SIGU will be computed internally from the Monte Carlo value of VWTE for each run of the run set.

(3) Monte Carlo Time Varying Wind Only - Input SIGU. The time varying wind component will be randomly generated from MCARLO white noise. The expected standard deviation SIGU is input via type 3 data card. The steady state wind magnitude VWTE is not randomly selected, but the wind direction BPSIW is. VWTE is computed internally from SIGU. It should be noted that VWTE = 0 must be input via type 3 data card.

(4) Monte Carlo Time Varying Wind Only - Compute SIGU. The time varying wind component will be randomly generated from MCARLO white noise. The expected standard deviation is not input, but is computed internally from VWTE. The steady state wind magnitude VWTE is not randomly selected, but is input via type 3 data card. The

TABLE 30. WIND INPUT COMBINATIONS

	Type 8 Card Input			Type 3 Card Input			Compute Internally	
	1	2	3	4	5	6	7	8
	Wind Gust Flag GVWTE C(70)	Steady State Flag VWTE C(52)	Wind Direction Flag BPSIW C(51)	SIGU (σ_u) C(54)	Mean Steady State Value VWTE C(52)	Mean Wind Direction BPSIW C(51)	VWTE = 2.9 SIGU	SIGU = $\frac{\text{VWTE}}{2.9}$
1	No	Yes	Yes	No	Yes	Yes		
2	Yes	Yes	Yes	No	Yes	Yes		Yes
3	Yes	No	Yes	Yes	Yes VWTE = 0	Yes	Yes	
4	Yes	No	Yes	No	Yes VWTE $\neq$ 0	Yes		Yes

wind direction BPSIW is randomly selected from a user specified probability distribution. An example output of combination (3) is given in Figure 22.

e. Input/Output Variables and Cross Reference of C-Array

Tables 31, 32, and 33 present the input/output variables and cross reference of C-array for module G2.

TABLE 31. INPUT FROM DATA CARDS - MODULE G2

Fortran Symbol	Symbol Used in Text	C Index	Definition
OPTNW		50	Wind option selector: 0 - no winds 1 - include steady winds
BPSIW	ψ_{WIND}	51	Wind direction: angle between wind velocity vector and the negative X-axis (deg)
VWTE	V_{WIND}	52	Wind speed with respect to the ground (ft/sec)

TABLE 32. INPUT FROM OTHER MODULES - MODULE G2

Fortran Symbol	Symbol Used in Text	C Index	Definition
BLU	L_u	56	Scale length
WNDWO	ω_T	58	Time dependent frequency
SLWD	$\dot{X}$	59	Filter variable
RLW	R_{LW}	60	White noise
SLW	X	62	Filter variable
CBPSIW	$\cos(\psi_{WIND})$	65	X-component of wind direction
SBPSIW	$\sin(\psi_{WIND})$	66	Y-component of wind direction
GSIGU	-	69	Temporary variable = $\sigma_u \sqrt{\frac{1.89}{\Delta t}}$

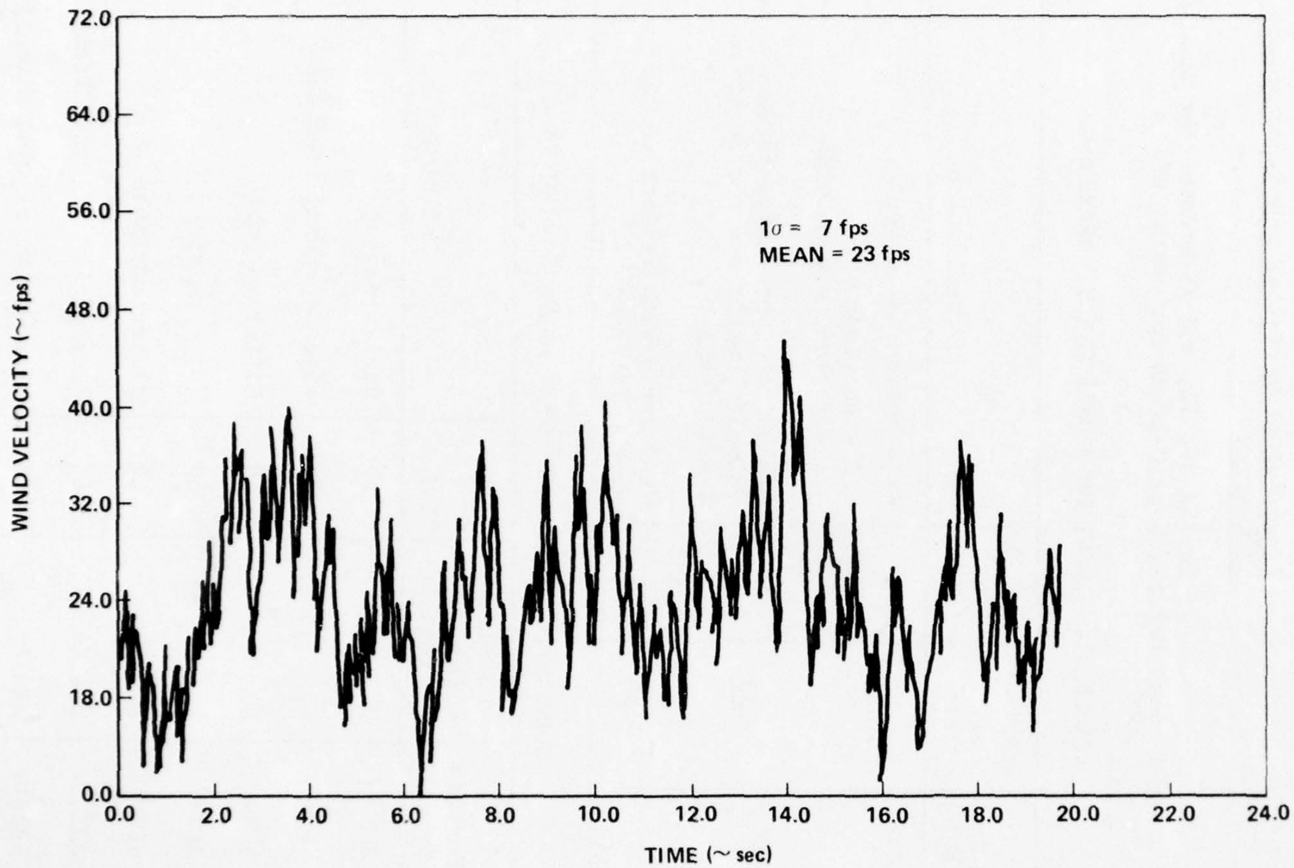


Figure 22. Typical wind gusts output.

TABLE 33. OUTPUT - MODULE G2

Fortran Symbol	Symbol Used in Text	C Index	Definition
VWXE	V_{XWIND}	100	Components of the wind velocity relative to the earth fixed coordinate system (ft/sec)
VWYE	V_{YWIND}	101	
VWZE	V_{ZWIND}	102	

f. Wind Monte Carlo Variables

The variables associated with the Monte Carlo wind model are given in Table 34.

TABLE 34. MONTE CARLO INPUTS - MODULE G2

Program Variable Name of Error Source	C Index of Error Source	Program Module Calling MCARLO	MCARLO Flag*		Definition
			Name	Index	
BPSIW	51	G2I	BPSIW	51	Wind direction (deg)
VWTE	52	G2I	VWTE	52	Steady state wind magnitude (ft/sec)
GVWTE	70	(G2I G2)	GVWTE	70	Total wind magnitude, steady state plus time varying
SIGU	54	-	-	-	Time varying wind standard deviation (ft/sec). Input by type 3 data card

*MCARLO is flagged by the C-index of this variable in the calling module.

When MCARLO is flagged by this C-index, a random number will be returned from MCARLO for the error source in the first column.

9. G3 - Air Data

a. Functional Description

Subroutine G3 computes the missile velocity with respect to the wind, and two atmospheric properties, density and speed of sound. The magnitude of the missile velocity, the atmospheric density and speed of sound are then used to compute Mach number and dynamic pressure.

b. Equations

1) Missile velocity with respect to wind -

$$\overline{V}_{MW} = \overline{V}_{MISSILE} - \overline{V}_{WIND} \quad .$$

2) Missile altitude -

$$h = -R_{ZE} + R_{ZO}$$

where

R_{ZE} = Z-component of missile position in earth coordinates

R_{ZO} = Altitude of earth coordinate system above ground.

3) Atmospheric density -

$$\rho = \frac{\rho_0}{1 + kh + k_1 h^3}$$

where

$\rho_0 = 0.076475$

$k = 0.3325 \times 10^{-4}$

$k_1 = 0.02315 \times 10^{-12}$.

4) Atmospheric speed of sound -

$$a = k_2 h + a_0$$

where

$a_0 = 1117.3$

$k_2 = -0.00392$.

5) Dynamic pressure -

$$P = \frac{1}{2} \rho \frac{|\bar{V}_{MW}|^2}{g_0} \quad .$$

6) Mach number -

$$M = \frac{|\bar{V}_{MW}|}{a} \quad .$$

c. Input/Output Variables and Cross Reference of C-Array

Tables 35, 36, and 37 present input/output variables and cross reference of C-array for module G3.

TABLE 35. INPUT FROM DATA CARDS - MODULE G3

Fortran Symbol	Symbol Used in Text	C Index	Definition
RHZRO	R_{ZO}	208	Altitude of earth fixed coordinate system above ground (ft)

TABLE 36. INPUT FROM OTHER MODULES - MODULE G3

Fortran Symbol	Symbol Used in Text	C Index	Definition
VWXE VWYE VWZE	$\bar{V}_{WIND}$	100 101 102	Wind velocity components in earth fixed coordinate system (ft/sec)
VXE VYE VZE	$\bar{V}_{MISSILE}$	1603 1607 1611	Velocity components of missile in earth fixed coordinate system (ft/sec)
RZE	R_{ZE}	1623	Z-component of missile position in earth fixed coordinate system (ft)

TABLE 37. OUTPUT - MODULE G3

Fortran Symbol	Symbol Used in Text	C Index	Definition
VMWXE, VMWYE, VMWZE	$\bar{V}_{MW}$	200, 201, 202	Components of missile velocity relative to the wind in the earth fixed coordinate system (ft/sec)
PDYNMC	$\dot{P}$	203	Dynamic pressure (lb/ft^2)
VMACH	M	204	Mach number
DRHO		205	Atmospheric density (lb/ft^3)
VSOUND	a	206	Atmospheric speed of sound (ft/sec)
VAIRSP	$\lvert\bar{V}_{MW}\rvert$	207	Magnitude of missile velocity relative to wind (airspeed) (ft/sec)
RH	h	209	Altitude of missile above ground (ft)

10. G4 - Terminal Geometry

a. Functional Description

This subroutine monitors the line-of-sight vector $\overline{\Delta R}(t)$ at the end of each integration step to determine if the point of closest approach (target plane intersection) to the target has been passed. If the closest approach point has been passed, integration is halted and the time of closest approach (t_0), the position of the target with respect to the missile ($\overline{\Delta R}_0$), and the miss distance (RMISS) are computed. After computation of the miss distance, two optional sets of data are also computed at this point. If there are any "type 10" input cards (IMVCT > 0), then the mean and standard deviation for the specified "type 10" parameters are computed. Also, if any time series Monte Carlo variables are present (ITCT > 0), then several laser spot jitter parameters are computed and printed. These include the maximum deviation of the laser spot jitter components and the mean and mean square values of the spot jitter components. After these computations, LCONV is set to 2 to flag subroutine STGE3 that the trajectory computation is to be terminated.

The time and position at closest approach are computed by linear interpolating the time (t_1) and position ($\overline{\Delta R}_1$) values just prior to closest approach and the time (t_2) and position ($\overline{\Delta R}_2$) values following closest approach (Figure 23). The time and position values following closest approach exist as current values of time (t) and position ($\overline{\Delta R}$) on the trajectory, while the time (t_1) and position ($\overline{\Delta R}_1$) just prior to closest approach were saved on the previous pass through this subroutine.

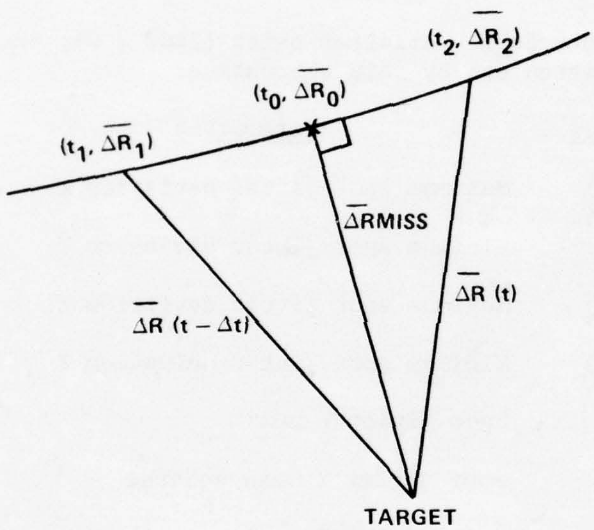


Figure 23. Point of closest approach.

G4 also monitors the altitude (RDELZ) of the missile relative to the target. If the altitude becomes negative, it is assumed that ground impact has occurred. If ground impact does occur, the run termination switch, LCONV, is set to 2 to flag STGE3 to terminate trajectory computation.

After bracketing the closest approach point and interpolation for the time and position, the following parameters are output via this subroutine:

Parameter	Definition
RMISS	Miss distance (ft)
t_0	Flight time at closest approach (sec)

Parameter	Definition
RDELX(ΔX) RDELY(ΔY) RDELZ(ΔZ)	Position components of the target with respect to the missile in the system centered at the missile and parallel to the earth fixed frame (ft)
RYFP(YFP) RZFP(ZFP)	Position components of the target in the flight plane frame (the X-component is not output since it is assumed to be zero) (ft)

If time series Monte Carlo variables exist (ITCT > 0), then the following parameters are written out by this subroutine:

Parameter	Definition
C(1567)	Maximum spot jitter deviation Y
C(1568)	Minimum spot jitter deviation Y
C(1577)	Maximum spot jitter deviation Z
C(1578)	Minimum spot jitter deivation Z
YMC	Spot jitter Y mean
YMC2	Spot jitter Y mean squared
ZMC	Spot jitter Z mean
ZMC2	Spot jitter Z mean squared
XMCSPOT	Spot jitter radial root mean squared

b. Equations

To monitor the line-of-sight vector, the position of the target is first transformed into a flight path coordinate system aligned with missile velocity by

$$\overline{RFP} = [M]\ \overline{\Delta R} \quad ,$$

where

$$\overline{\Delta R} = \begin{bmatrix} \Delta X \\ \Delta Y \\ \Delta Z \end{bmatrix}$$ Position of target with respect to missile in a system parallel to the earth fixed coordinate system

$$\overline{RFP} = \begin{bmatrix} XFP \\ YFP \\ ZFP \end{bmatrix}$$ Position of target with respect to missile in flight plaee coordinate system

and

$$M = \begin{bmatrix} \cos\gamma_H \cos\gamma_V & \sin\gamma_H \cos\gamma_V & -\sin\gamma_V \\ -\sin\gamma_H & \cos\gamma_H & 0 \\ \cos\gamma_H \sin\gamma_H & \sin\gamma_H \sin\gamma_H & \cos\gamma_H \end{bmatrix} .$$

The previously mentioned transformation involves a rotation from the earth fixed axes through the heading angle γ_H and the flight path and γ_V to the flight plane coordinate system as shown in Figure 24.

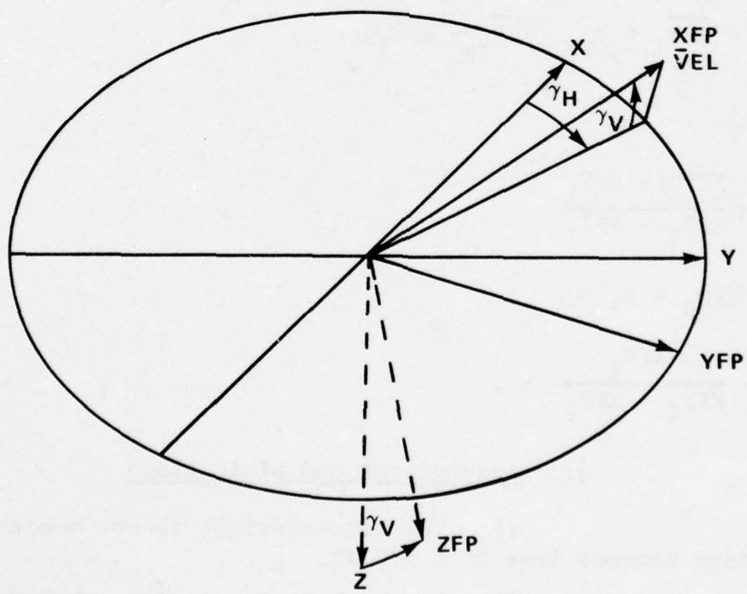


Figure 24. Flight plane coordinate system.

Transforming the line-of-sight vector into the flight plane coordinate system simplifies the determination of closest approach passage, because the X-component (XFP) of the line-of-sight will be

zero at closest approach. This condition exists because the X-axis (XFP) is coincident with the velocity vector and the line-of-sight is normal to the velocity at the closest approach point.

To determine closest approach passage, the value of XFP is monitored. A positive XFP means the target lies ahead of the missile. A negative XFP means the target lies behind the missile. When the value of XFP changes sign from one integration step to the next, closest approach has been bracketed. At this time, integration is halted and the time (t_0) and position ($\overline{\Delta R}_0$) of closest approach is computed by interpolation. Interpolation is performed using XFP as the independent variable. Thus,

$$t_0 = t_1 + P_{CT} (t_2 - t_1)$$

$$\overline{\Delta R}_0 = \overline{\Delta R}_1 + P_{CT} (\overline{\Delta R}_2 - \overline{\Delta R}_1)$$

and

$$\overline{RFP}_0 = \overline{RFP}_1 + P_{CT} (\overline{RFP}_2 - \overline{RFP}_1) \quad ,$$

where

$$P_{CT} = \frac{XFP_0 - XFP_1}{XFP_2 - XFP_1} \quad ;$$

and since $XFP_0 = 0$,

$$P_{CT} = \frac{-XFP_1}{XFP_2 - XFP_1} \quad .$$

c. Assumptions and Limitations

1) The line-of-sight is not monitored until a slant range becomes less than 500 ft.

2) For a slant range greater than 500 ft, the Z-component (RDELZ) of the target with respect to the missile is monitored to determine ground impact.

3) The flight plans coordinate system is aligned with the missile earth fixed velocity vector. If appreciable target motion exists, then the condition that the X-component (XFP) of $\overline{RFP}$ is equal to zero at the point of closest approach to the target is not precisely true.

d. <u>Input/Output Variables and Cross Reference of C-Array</u>

Tables 38 and 39 present the input/output variables and cross reference of C-array for module G4.

TABLE 38. INPUT FROM OTHER MODULES - MODULE G4

Fortran Symbol	Symbol Used in Text	C Index	Definition
BGAMH	γ_H	357	Horizontal flight path angle (heading) (deg)
BGAMV	γ_V	358	Vertical flight path angle (deg)
RANGE		371	Distance from target (ft)
RDELX RDELY RDELZ	ΔX ΔY ΔZ	1635 1636 1637	Position components of target (line-of-sight) with respect to the missile in earth fixed coordinate system (ft)
T	t	2000	Flight time (sec)
ITCT	ITCT	3721	Total number "type 8" parameters
IMVCT	IMVCT	3030	Total number "type 10" parameters
IMVNDX		3020	The mean, standard deviation variable C-index that appears on the "type 10" card
YMC	YMC	1564	Spot jitter Y mean
YMC2	YMC2	1565	Spot jitter Y mean squared
ZMC	ZMC	1574	Spot jitter Z mean
ZMC2	ZMC2	1575	Spot jitter Z mean squared

11. G5 - Coordinate Conversion Module

a. <u>Functional Description</u>

G5 computes all the angles pertaining to the position and velocity of the vehicle (the proportional navigation angles and look vector angles) and makes three coordinate transformations.

TABLE 39. OUTPUT - MODULE G4

Fortran Symbol	Symbol Used in Text	C Index	Definition
LCONV	LCONV	2020	Integration termination switch
RMISS	RMISS	300	Miss distance (measured in target plane)
RXF	YFP	301	Position components of target with respect to missile in the flight plane coordinate system (ft)
RYF	YFP	302	
RZF	ZFP	303	
VSD		3000	"Type 10" parameter standard deviation
VMEAN		3010	"Type 10" parameter mean

The components of the spin axis of the 2-DOF gyro (inertial platform for roll attitude stabilization) is computed in the earth fixed coordinate system along with the two Euler angles defining the orientation of the gyro relative to the body coordinate system. The angles computed and the transformations made in this subroutine are:

1) Euler angles of the body coordinate system relative to the earth-fixed coordinate system.

2) Inertial platform gyro spin axis position components and Euler angles.

3) Target position with respect to the missile, missile total velocity, and missile position with respect to the moving rail launcher.

4) Transformation of missile line-of-sight from earth fixed coordinate system into the body coordinate system.

5) Vertical and horizontal line-of-sight angles.

6) Vertical and horizontal proportional navigation angles.

7) Vertical and horizontal flight path angles of the missile with respect to the earth fixed axes.

8) Transformation of the velocity relative to the air from the earth fixed coordinate system into the body coordinate system.

9) Angle of attack with respect to the wind.

a) Vertical (α) and horizontal (β) angles of attack.

b) Alpha prime (α' - absolute angle of attack) and phi prime (Φ' - aerodynamic roll angle with respect to wind) angles (wind tunnel axes).

b. Equations

(1) Euler Angles of the Body Coordinate System. The three Euler angles (γ, θ, Φ) are computed from elements of the earth-to-body transformation matrix, [M]. The matrix is computed in D2, the rotational dynamics subroutine, and passed into this subroutine by the COMMON BLOCK C. The matrix is defined as

$$M = \begin{bmatrix} C_{11} & C_{12} & C_{13} \\ C_{21} & C_{22} & C_{23} \\ C_{31} & C_{32} & C_{33} \end{bmatrix} \quad .$$

The relationship between each element value and the three Euler angles is given in Appendix C. It can be seen from these relationships that

$$\Phi = \tan^{-1} \frac{C_{23}}{C_{33}} \text{ (Euler roll)}$$

$$\theta = \tan^{-1} \frac{-C_{13}}{\sqrt{C_{11}^2 + C_{1}^2}} \quad \text{(Euler pitch)}$$

$$\psi = \tan^{-1} \frac{C_{12}}{C_{11}} \quad \text{(Euler yaw)} \quad .$$

(2) Inertial Platform Position Components and Euler Angles. The inertial platform is a 2 DOF gyro. The gyro is oriented with its spin axis aligned with the initial Y-body axis of the vehicle as shown in Figure 25. The outer gimbal is aligned with the roll axis of the missile, and the inner gimbal is aligned with the yaw axis as shown in Figure 26.

Gyro initial orientation matrices are set in D2I, the rotational dynamics initialization subroutine. The gyro matrix is defined as:

$$A0 = \begin{bmatrix} A0_{11} & A0_{12} & A0_{13} \\ A0_{21} & A0_{22} & A0_{23} \\ A0_{31} & A0_{32} & A0_{33} \end{bmatrix} \quad ,$$

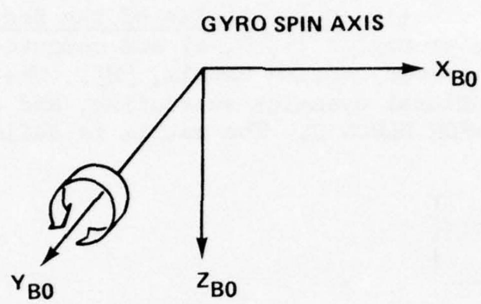


Figure 25. Initial orientation of the 2 DOF gyro.

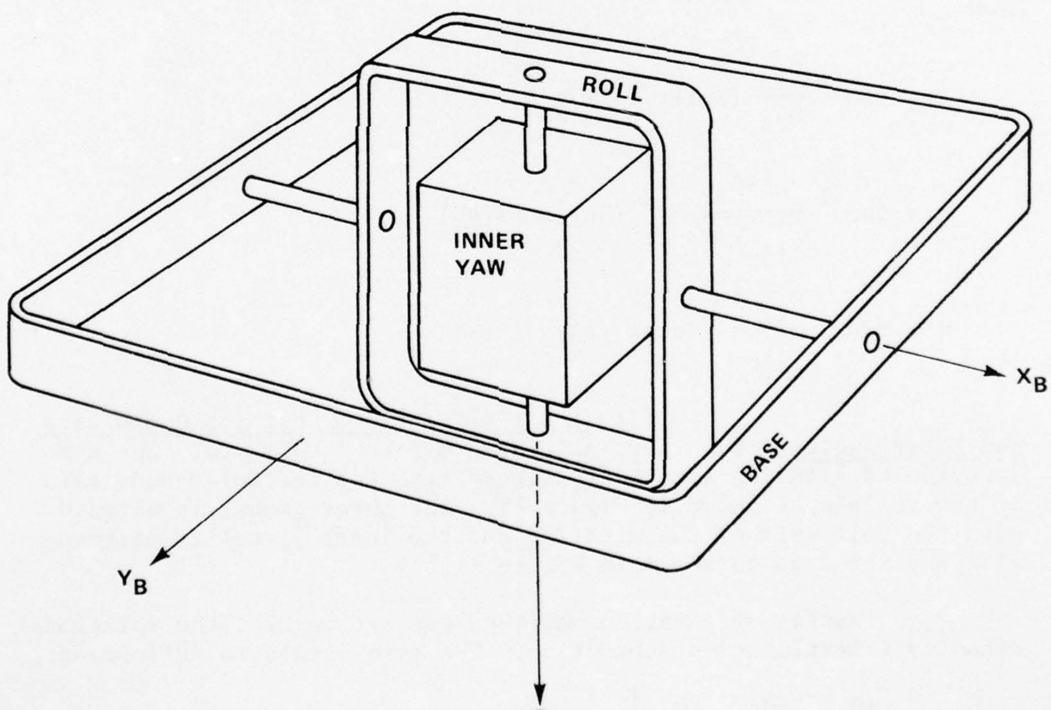


Figure 26. Roll gyro orientation.

where

$$\begin{bmatrix} AO_{11} & AO_{12} & AO_{13} \\ AO_{21} & AO_{22} & AO_{23} \\ AO_{31} & AO_{32} & AO_{33} \end{bmatrix} = \begin{bmatrix} C_{11} & C_{12} & C_{13} \\ C_{21} & C_{22} & C_{23} \\ C_{31} & C_{32} & C_{33} \end{bmatrix}_{\text{at } t = 0} \quad .$$

The elements are taken from the earth-to-body coordinate system transformation matrix M computed at the initial time point or, $[AO] = [M]_{\text{at } t = 0}$. This subroutine (G5) transforms the axes of the gyro from the initial body coordinate system through the earth fixed system to the current body coordinate system and then computes the roll angle detected by the gyro. Thus,

$$\begin{bmatrix} X_B \\ Y_B \\ Z_B \end{bmatrix}_{GYRO} = [M]\ [AO]^T \begin{bmatrix} X_{BO} \\ Y_{BO} \\ Z_{BO} \end{bmatrix}_{GYRO} \quad .$$

Substituting the components of the gyro ($X_{BO} = 0$, $Y_{BO} = 1$, $Z_{BO} = 0$) into the previously mentioned equation gives,

$$\begin{bmatrix} X_B \\ Y_B \\ Z_E \end{bmatrix}_1 = \begin{bmatrix} C_{11}AO_{21} + C_{12}AO_{22} + C_{13}AO_{23} \\ C_{21}AO_{21} + C_{22}AO_{22} + C_{23}AO_{23} \\ C_{31}AO_{21} + C_{32}AO_{22} + C_{33}AO_{23} \end{bmatrix} \quad .$$

The roll angle is shown in Figure 27 and is computed by

$$\Phi_1 = \tan^{-1}\left(\frac{Z_{B1}}{Y_{B1}}\right) \quad .$$

(3) <u>Target Position (Line-of-Sight Vector) with Respect to the Missile, Missile Total Velocity, and Missile Position with Respect to the Moving Rail Launcher</u>. The missile total velocity in the earth fixed coordinate system is

$$V_{TOTE} = \sqrt{V_{XE}^2 + V_{YE}^2 + V_{ZE}^2} \quad .$$

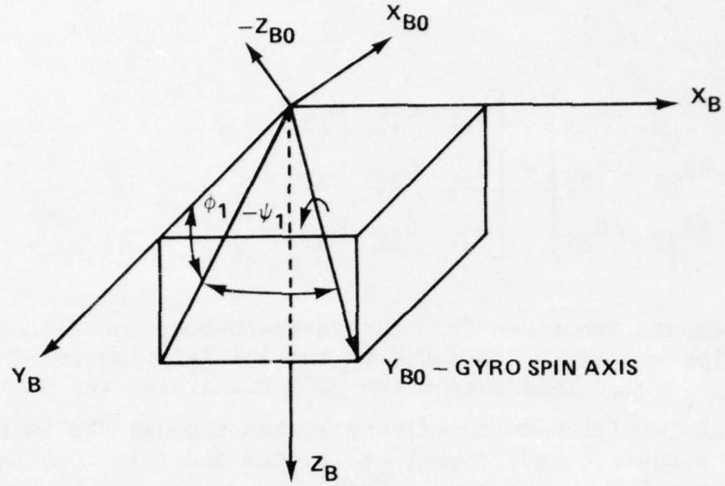


Figure 27. Gyro Euler angles.

The target position (line-of-sight vector) with respect to the missile (Figure 28) is

$$\bar{R}_{\nabla} = \bar{R}_T - \bar{R}_E \quad \text{(line-of-sight vector)} \quad .$$

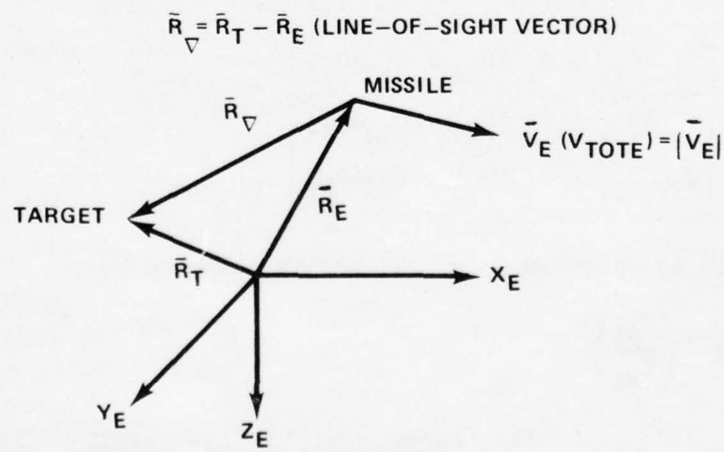


Figure 28. Earth fixed coordinate system.

To determine missile separation from the launch rail, the position and motion of the rail is required along with the position and motion of the missile. The motion of the rail is assumed to be composed of a constant linear velocity with respect to the earth ($\bar{V}_0$, the missile initial velocity, Figure 29).

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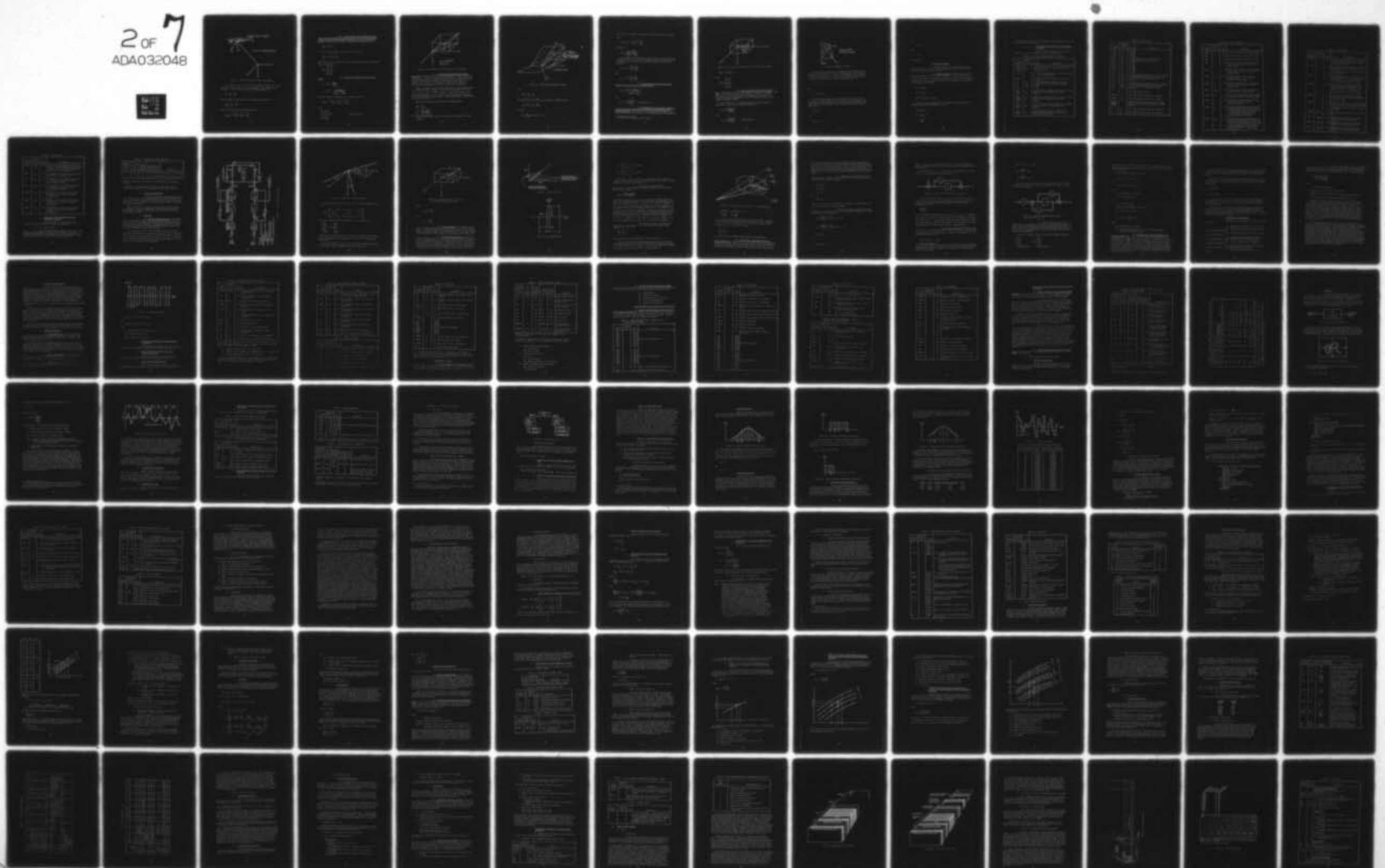

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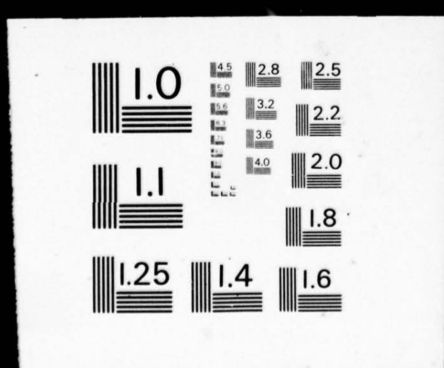


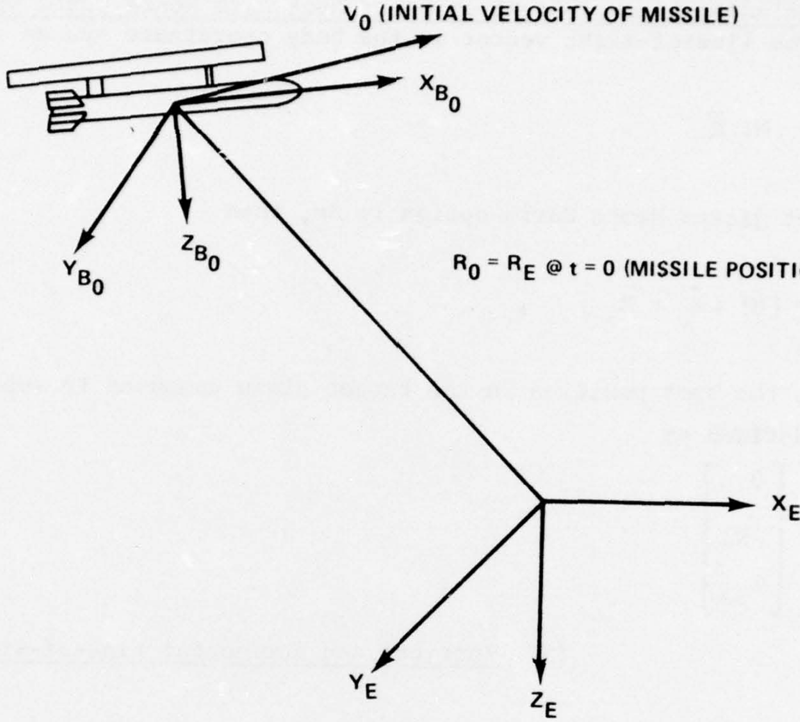


Figure 29. Launcher initial position and velocity.

The initial position of the rail is assumed to be $\overline{R}_0$, the initial position of the missile. Thus, the position of the launcher as a function of time in the earth fixed coordinate system is

$$\overline{R}_L = \overline{R}_E + \overline{V}_0 t \quad .$$

Missile position with respect to the launcher then becomes

$$\Delta\overline{R}_{ML} = \overline{R}_E - \overline{R}_L \quad ,$$

with the magnitude of the separation being

$$R_{ANGO} = \sqrt{\Delta X_{ML}^2 + \Delta Y_{ML}^2 + \Delta Z_{ML}^2} \quad .$$

(4) <u>Transformation of the Missile Line-of-Sight from the Earth Fixed Coordinate System into the Body Coordinate System, Including Line-of-Sight of Laser Spot with Monte Carlo Spot Jitter</u>. The line-of-sight vector in the body coordinate system is

$$\bar{R}_{TB} = [M]\ \bar{R}_{\nabla} \quad .$$

If the spot jitter Monte Carlo option is on, then

$$\bar{R}_{TB} = [M]\ [\bar{R}_{\nabla} + \bar{R}_{SJ}] \quad ,$$

where $\bar{R}_{SJ}$, the spot position in the target plane computed in subroutine SPOT, is defined as

$$\bar{R}_{SJ} = \begin{bmatrix} 0 \\ Y_{SJ} \\ Z_{SJ} \end{bmatrix} \quad .$$

(5) <u>Vertical and Horizontal Line-of-Sight Angles</u>.

$$\gamma_H = \tan^{-1} \frac{-\Delta Y_{LOS}}{\Delta X_{LOS}}$$

$$\gamma_V = \tan^{-1} \frac{-\Delta Z_{LOS}}{\sqrt{\Delta X_{LOS}^2 + \Delta Y_{LOS}^2}}$$

The slant range from missile to the target is given as

$$RANGE = \sqrt{\Delta X_{LOS}^2 + \Delta Y_{LOS}^2 + \Delta Z_{LOS}^2} \quad ,$$

where

$$\begin{bmatrix} \Delta X_{LOS} \\ \Delta Y_{LOS} \\ \Delta Z_{LOS} \end{bmatrix} = \bar{R}_{\nabla} \quad . \qquad \text{(See Figure 30).}$$

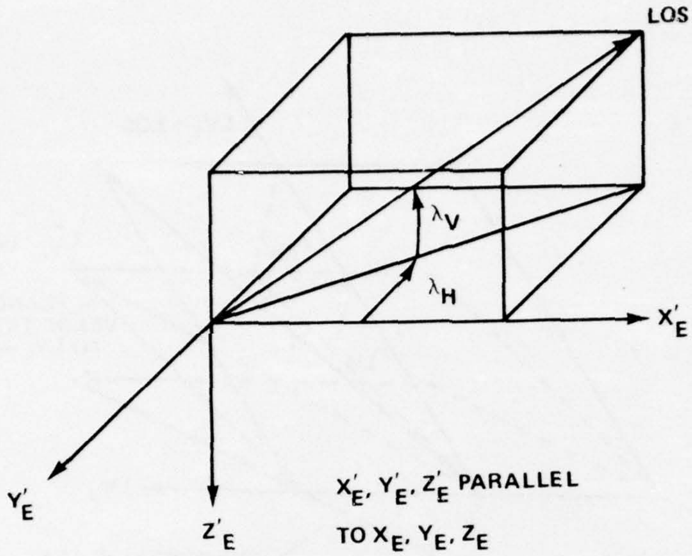


Figure 30. Vertical and horizontal line-of-sight angles.

(6) Vertical and Horizontal Proportional Navigation. Vertical and horizontal proportional navigation angles are defined in the coordinate system shown in Figure 31. The vertical and horizontal proportional navigation angles gives the orientation of the missile velocity vector relative to the line-of-sight vector. In deriving these angles, the assumption is made that the velocity of the target is negligible with respect to the missile velocity.

This coordinate system is established with the line-of-sight vector as the $\overline{LV}_1$-axis; $\hat{LV}_2$ is normal to the line-of-sight vector and lying in a horizontal plane; and $\overline{LV}_3$ completes a right-handed system. The proportional navigation angles are the angles defining the orientation of the missile velocity with respect to the line-of-sight. These angles are shown in Figure 31.

The line-of-sight coordinate system is established by

$$\overline{LV}_1 = \overline{\Delta R}_{LOS}$$

$$\hat{LV} = \frac{(\hat{k}_E \times \overline{LV}_1)}{|\hat{k}_E \times \overline{LV}_1|} \quad *$$

---

*k_E is a unit vector along the Z_E-axis, and $\times$ represents a cross product.

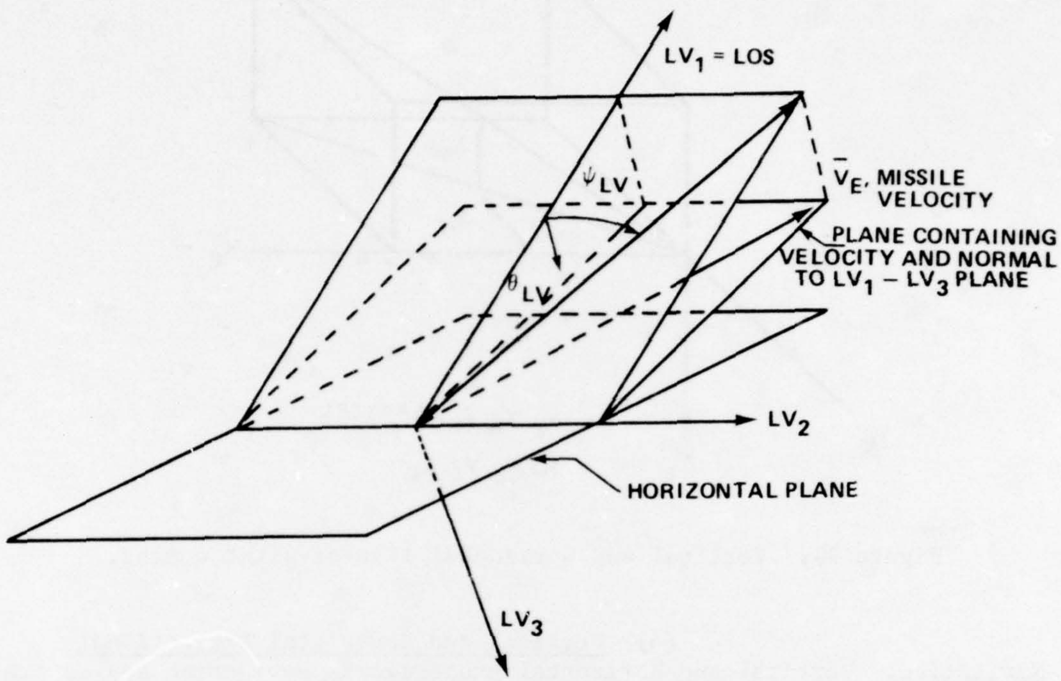


Figure 31. Proportional navigation angles.

and

$$\overline{LV}_3 = \overline{LV}_1 \times \hat{LV}_2 \quad .$$

The magnitude of $\hat{k}_E' \times \overline{LV}_1$ may be found by considering that

$$\hat{k}_E \times \overline{LV}_1 = \hat{k}_E \times \overline{\Delta R}_{LOS}$$

and that

$$\hat{k}_E \times \overline{\Delta R}_{LOS} = (\Delta R \sin \beta)\ \hat{\gamma} \quad .$$

Now, $\Delta R \sin \beta$ is simply the projection of ΔR into the X_E - Y_E plane.

Thus,

$$\Delta R \sin \beta = \sqrt{\Delta X_{LOS}^2 + \Delta Y_{LOS}^2} \quad .$$

Therefore,

$$\hat{LV}_2 = \frac{(\hat{k}_E \times \overline{LV}_1)}{\sqrt{\Delta X_{LOS}^2 + \Delta Y_{LOS}^2}} \quad .$$

To determine the navigation angles, the missile velocity is projected onto each axis of the LV coordinate system. This produces the components of the velocity in this system. Thus, the angles are computed by

$$\theta_{LV} = \tan^{-1} \frac{\overline{V}_E \cdot \hat{LV}_3}{\overline{V}_E \cdot \hat{LV}_1} \quad *$$

and

$$\psi_{LV} = \tan^{-1} \frac{\overline{V}_E \cdot \hat{LV}_2}{\overline{V}_E \cdot \hat{LV}_1} \quad .$$

(7) Vertical and Horizontal Flight Path Angles in the Earth Fixed Coordinate System.

$$\gamma_V = \tan^{-1}\left(\frac{-V_{ZE}}{\sqrt{V_{XE}^2 + V_{YE}^2}}\right)$$

and

$$\gamma_H = \tan^{-1}\left(\frac{V_{YE}}{V_{XE}}\right) \quad \text{(see Figure 32)} \quad .$$

(8) Transformation of the Velocity Relative to the Wind from the Earth Fixed Coordinate System into the Body Coordinate System. The velocity of the missile with respect to the wind, calculated in subroutine G3, is transformed into the body axes by

---

*The dot "." represents a dot product.

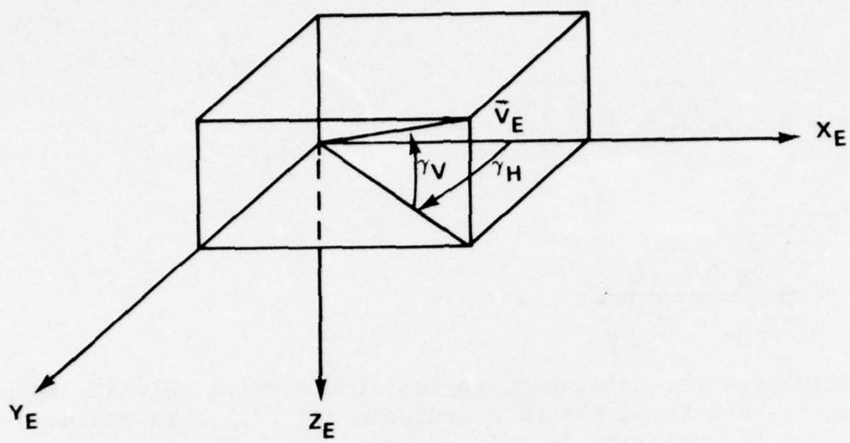


Figure 32. Vertical (γ_V) and horizontal (γ_H) flight path angles.

$$\bar{V}_{MWB} = [M]\ \bar{V}_{MWE} \quad ,$$

where

$$\bar{V}_{MWB} = \begin{bmatrix} V_{MWU} \\ V_{MWV} \\ V_{MWW} \end{bmatrix} \quad .$$

(9) <u>Angle of Attack with Respect to Wind Axes</u>. The geometry relating to the angles of attack of the missile with respect to the wind is illustrated in Figure 3 of Section III.B.1 and Figure 33. The calculation of these angles is bypassed if the engine is thrusting (Flag QBURN $\leq$ 0) and the missile is still on the launch rail (RANGO $\leq$ RAIL).

The vertical angle of attack (α) and the horizontal angle of attack (β) is given in the following equations:

$$\alpha = \tan^{-1}\left(\frac{V_{MWW}}{V_{MWU}}\right)$$

and

$$\beta = \tan^{-1}\left(\frac{V_{MWV}}{V_{MWU}}\right) \quad . \qquad \text{(See Figure 33)}$$

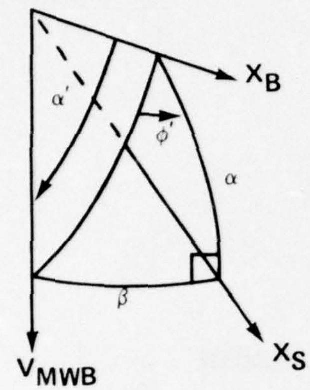


Figure 33. Angles of attack.

From spherical trigonometry and assuming a small angle of side-slip, β, (the small angle β allows a right triangle to be formed by the chords of the angles α, β, and α') the absolute angle of attack, α', and the roll angle of the missile with respect to the wind axes, ϕ', may be computed based on small angle approximations by

$$\alpha'^2 = \alpha^2 + \beta^2$$

and

$$\phi' = \tan^{-1} \frac{\alpha}{\beta} \quad .$$

Conventionally, small angle approximations limits the angle magnitudes to approximately 10°. However, in the derivation of the previously mentioned equations, half angles ($\alpha/2$, $\beta/2$) appear in the formulas that are simplified through the small angle approximation. Thus, since

$$\frac{\alpha}{2} \leq 10°$$

and

$$\frac{\beta}{2} \leq 10° \quad ,$$

then

$$\alpha \leq 20°$$

and

$$\beta \leq 20°$$

is allowed.

c. Random Error Sources

G5 contains logic for the computation of one Monte Carlo error source, the roll attitude gyro drift. D1I sets the initial value for this error source.

(1) Roll Gyro Drift. The roll gyro is a 2 DOF gyro and is assumed to have drift in both axes. The drift rates, P_1 and R_1, about the roll and yaw axes, respectively, are selected randomly in D1I. The effect of these drift rates are transformed to the position coordinates of the gyro by

$$\dot{X}_1 = R_1 Z_{B01}$$

$$\dot{Y}_1 = P_1 Z_{B01}$$

$$\dot{Z}_1 = (P_1 Y_{B01} - R_1 X_{B01}) \quad .$$

Since the rates are assumed to be constant, gyro position can be determined by direct integration. Thus,

$$X_1 = \dot{X}_{B01} t$$

$$Y_1 = \dot{Y}_{B01} t + 1$$

$$Z_1 = \dot{Z}_{B01} t$$

(The integration constants for the position coordinates are 0, 1, 0 as stated in Section III.B.11.b).

d. Input/Output Variables and Cross Reference of C-Array

Tables 40 and 41 present the input/output variables and cross reference of C-array for module G5.

TABLE 40. INPUTS FROM OTHER MODULES - MODULE G5

Fortran Symbol	Symbol Used in Text	C Index	Definition
VMWXE VMWYE VMWZE	$\overline{V}_{MWE}$	200 201 202	Components of missile velocity relative to the wind in earth fixed system (ft/sec)
VAIRSP		207	Velocity magnitude of missile relative to wind (ft/sec)
QBURN		1405	Engine burnout switch (1 = burnout)
VXE VYE VZE	V_{XE} V_{YE} V_{ZE}	1603 1607 1611	Components of missile velocity in earth fixed coordinate (ft/sec)
RXE RYE RZE	$\overline{R}_E$	1615 1619 1623	Position components of missile in earth fixed coordinate system (ft)
RTXE RTYE RTZE	$\overline{R}_T$	1651 1655 1659	Position components of target in earth fixed coordinate system (ft)
RXO RYO RZO	$\overline{R}_O$	1668 1669 1670	Initial position components of missile and rail in fixed system (ft)
VXO VYO VZO	$\overline{V}_O$	1671 1672 1673	Initial velocity - components of missile and rail in earth fixed system (ft/sec)

TABLE 40. (Concluded)

Fortran Symbol	Symbol Used in Text	C Index	Definition
CFA11	C_{11}	1703	Elements of the earth-to-body transformation matrix, M
CFA12	C_{12}	1707	
CFA13	C_{13}	1711	
CFA21	C_{21}	1715	
CFA22	C_{22}	1719	
CFA23	C_{23}	1723	
CFA31	C_{31}	1727	
CFA32	C_{32}	1731	
CFA33	C_{33}	1735	
A021	$A0_{21}$	1755	Position components of gyro 1 (inertial platform) spin axis unit vector in earth fixed coordinate system
A022	$A0_{22}$	1756	
A023	$A0_{23}$	1757	
A031	$A0_{31}$	1758	Position components of gyro 2 (inertial platform) spin axis unit vector in earth fixed coordinate system
A032	$A0_{32}$	1759	
A033	$A0_{33}$	1760	
T	t	2000	Flight time (sec)
RSJYMC	Y_{SJ}	1680	Y-component actual spot location
RSJZMC	Z_{SJ}	1681	Z-component actual spot location
RSPOTX		1682	Target position components in earth fixed system with spot jitter added
RSPOTY		1683	
RSPOTZ		1684	
P1	P_1	1764	Roll gyro roll drift rate (deg/sec)
R1	R_1	1765	Roll gyro yaw drift rate (deg/sec)

TABLE 41. OUTPUT - MODULE G5

Fortran Symbol	Symbol Used in Text	C Index	Definition
BTHT	θ	350	Euler pitch angle of body system (deg)
BPSI	ψ	351	Euler yaw angle of body system (deg)
BPHI	Φ	352	Euler roll angle of body system (deg)
BPH1	Φ_1	353	Euler roll angle of inertial platform (gyro 1) with respect to the body system (deg)
BTH2	θ_2	354	Euler pitch angle of inertial platform (gyro 2) with respect to the body system (deg)
BPS1	ψ_1	355	Euler yaw angle of the inertial platform (gyro 1) with respect to the body system (deg)
BPH2	Φ_2	393	Euler roll angle of inertial platform (gyro 2) with respect to the body system (deg)
VTOTE	V_{TOTE}	356	Missile total velocity magnitude in the earth fixed frame (ft/sec)
BGAMH	γ_H	357	Horizontal flight path angle (heading) measured clockwise from X_E-axis (deg)
BGAMV	ψ_V	358	Vertical flight path angle measured positive up from the local horizontal (deg)
BTHLV	θ_{LV}	363	Vertical proportional navigation angle, measured positive downward from the line-of-sight vector to the projection of the missile velocity into the vertical plane that contains the line-of-sight vector (deg)
BPSLV	ψ_{LV}	364	Horizontal proportional navigation angle measured positive clockwise from the line-of-sight vector to the projection of the missile velocity into the plane containing the line-of-sight vector and normal to the vertical plane (deg)

TABLE 41. (Continued)

Fortran Symbol	Symbol Used in Text	C Index	Definition
BLAMV	λ_V	365	Vertical line-of-sight angle, measured from the local horizontal to the line-of-sight vector (deg)
BLAMH	λ_H	366	Horizontal line-of-sight angle, measured from X_E-axis to the projection of the line-of-sight vector into local horizontal plane (deg)
BALPHA	α	367	Vertical angle of attack, measured from the projection of the missile velocity with respect to the wind into the X_B - Z_B plane and the X_B-axis (deg)
BALPHY	β	368	Horizontal angle of attack (sideslip) measured from the projection of the missile velocity with respect to the wind into the X_B - Z_B plane and the velocity relative to the wind (deg)
BALPHP	α'	369	Total angle of attack between vehicle X_B-body axis and the velocity relative to the wind (deg)
BPHIP	Φ'	370	Aerodynamic roll angle between the plane containing the Z_B - X_B axes and the plane containing X_B velocity relative to the wind (deg)
RANGE	RANGE	371	Slant range from missile to the target (ft)
RXBA	ΔX_{BLOS}	372	X-component of missile line-of-sight ($\overline{\Delta R}_{BLOS}$) in body coordinates (ft)
RYBA	ΔY_{BLOS}	373	Y-component of missile line-of-sight ($\overline{\Delta R}_{BLOS}$) in body coordinates (ft)
RZBA	ΔZ_{BLOS}	374	Z-component of missile line-of-sight ($\overline{\Delta R}_{BLOS}$) in body coordinates (ft)

TABLE 41. (Concluded)

Fortran Symbol	Symbol Used in Text	C Index	Definition
RANGO	R_{ANGO}	380	Magnitude of the separation distance between the rail launcher and the missile. (Measured from rear end of launcher to the rear lug of missile) (ft)
RXL	ΔX_{ML}	390	X-component of the missile position with respect to the launcher (ft)
RYL	ΔY_{ML}	391	Y-component of the missile relative to the launcher in the earth fixed coordinate frame (ft)
RZL	ΔZ_{ML}	392	Z-component of the missile relative to the launcher in the earth fixed coordinate frame (ft)
RDELX	ΔX_{LOS}	1635	X-component of missile line-of-sight ($\overline{\Delta R}_{LOS}$) in earth fixed coordinate system (ft)
RDELY	ΔY_{LOS}	1636	Y-component of missile line-of-sight ($\overline{\Delta R}_{LOS}$) in earth fixed coordinate system (ft)
RDELZ	ΔZ_{LOS}	1637	Z-component of missile line-of-sight ($\overline{\Delta R}_{LOS}$) in earth fixed coordinate system (ft)

e. <u>Monte Carlo Input Variables and Cross Reference of C-Array</u>

Table 42 presents the Monte Carlo input variables and cross reference of C-array for module G5.

12. S1 - Seeker Module

The seeker module, S1, currently used in the 6 DOF simulation program models a quadrant (laser) tracker. Two other seekers, a digital/linear laser seeker and an optical contrast seeker, are available as options as explained in Section III.B.12.h.

TABLE 42. MONTE CARLO INPUT - MODULE G5

Program Variable Name of Error Source	C Index of Error Source	Program Module Calling MCARLO	MCARLO Flag*		Definition
			Name	Index	
P1	1764	D1I	P1	1764	Roll gyro roll drift rate
R1	1765	D1I	R1	1765	Roll gyro yaw drift rate

*MCARLO is flagged by the C-index of this variable in the calling module.

When MCARLO is flagged by this C-index, a random number will be returned from MCARLO for the error source in the first column.

a. Functional Description

Figure 34 is the block diagram representation of the laser seeker as it is implemented in the 6 DOF simulation program. The transfer functions given in each of the blocks were transformed by use of the M-method into state variable format for solution by numerical integration.

There are options in module S1 for bypassing the lead integral compensation and platform compensation that are not shown in this block diagram. However, these options are dealt with in detail in the following sections.

b. Equations

(1) Line-of-Sight Calculation. The initial portion of the module logic determines target position (modeled as a point source) in the gimbal axes. This operation consists of transforming the X, Y, and Z components of target position from the body axes to the gimbal axes, then calculating the angular offsets (from the gimbal boresight axis) in pitch and yaw.

As is depicted in Figure 35, the gimbal axes, (X_G, Y_G, Z_G), orientation with respect to the body axes, (X_B, Y_B, Z_B), is specified by two rotations; the first through an angle of ψ_G about the Z_B-axis, and the second through an angle of θ_G about Y_G (the sign of the angles following the right-hand rule convention).

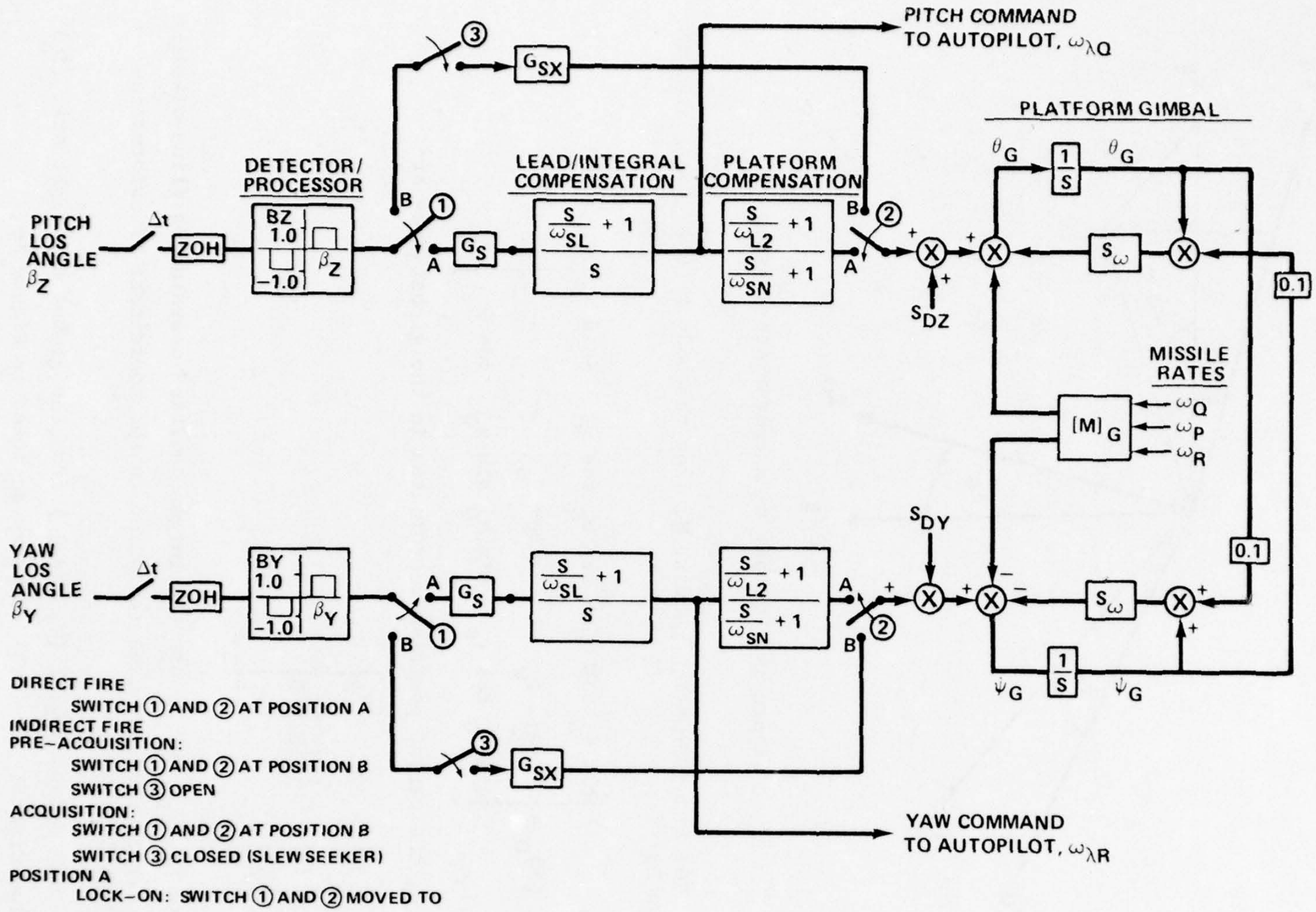


Figure 34. S1 seeker block diagram.

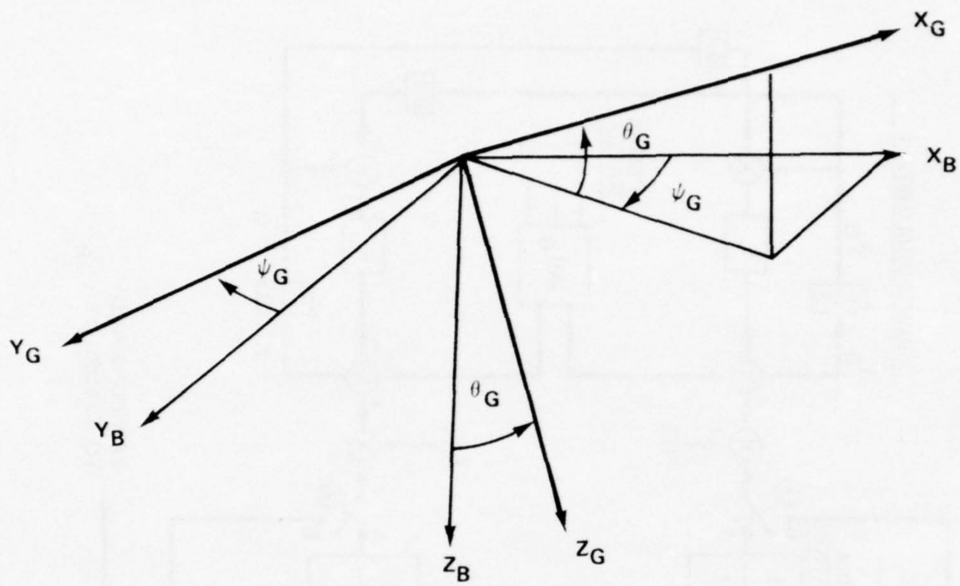


Figure 35. Gimbal axes coordinate system.

The transformation matrix, M, from the body to the gimbal axes is given by

$$[M]_G = \begin{bmatrix} \cos\theta_G \cos\psi_G & \sin\psi_G \cos\theta_G & -\sin\theta_G \\ -\sin\psi_G & \cos\psi_G & 0 \\ \sin\theta_G \cos\psi_G & \sin\theta_G \sin\psi_G & \cos\theta_G \end{bmatrix} .$$

Hence, the target position coordinates in the gimbal axes are

$$\begin{bmatrix} X_G \\ Y_G \\ Z_G \end{bmatrix}_G = [M]_G \begin{bmatrix} X_B \\ Y_B \\ Z_B \end{bmatrix}_B ,$$

where X_B, Y_B, and Z_B are the target position coordinates (line-of-sight vector) in the body axes (computed in the coordinate transformation module, G5).

The offset angles (β_Z and β_Y) from the gimbal boresight axis (X_G) follow directly from the geometry depicted in Figure 36.

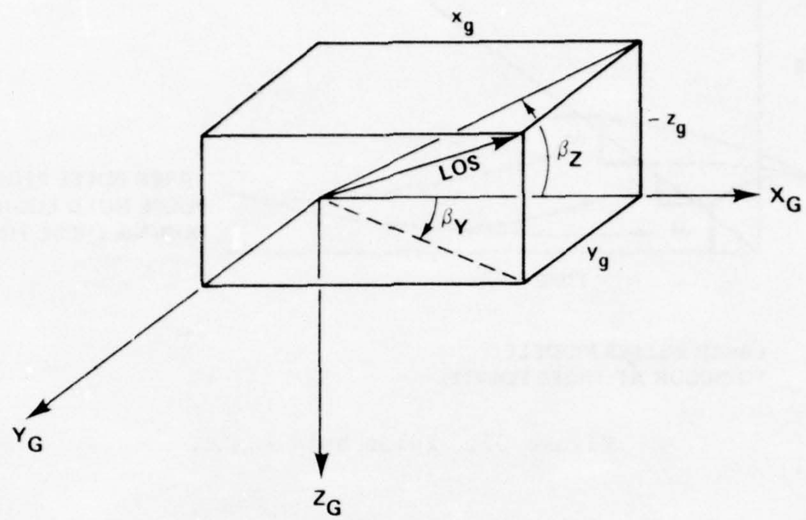


Figure 36. Angular offset of line-of-sight from seeker boresight axis (X_G).

Thus,

$$\beta_z = \tan^{-1} \frac{-z_g}{x_g}$$

and

$$\beta_y = \tan^{-1} \frac{y_g}{x_g} \quad .$$

(2) Pulse Hold Logic. The sampler and zero order hold (ZOH) represents the pulsed nature of the received laser energy. Modeling of these events is done by holding the last detector pulse Δt seconds, at which time a new laser pulse is received. Thus, the seeker detector time function will appear as shown in Figure 37.

(3) Seeker Detector/Processor. The laser seeker assembly, mounted on a two axis, momentum stabilized platform, contains a quadrant detector for sensing of laser energy reflected from the target and focused into a fixed diameter spot. The detector output, Figure 38, is processed by electronics into a signal of constant amplitude that changes in sign as the spot moves from quadrant to quadrant. Thus, the detector output signal in pitch and yaw is

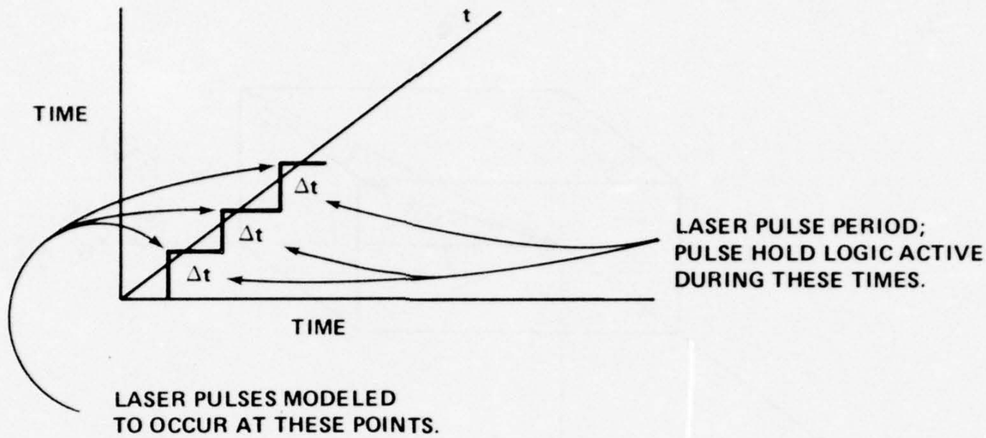


Figure 37. Pulse hold logic.

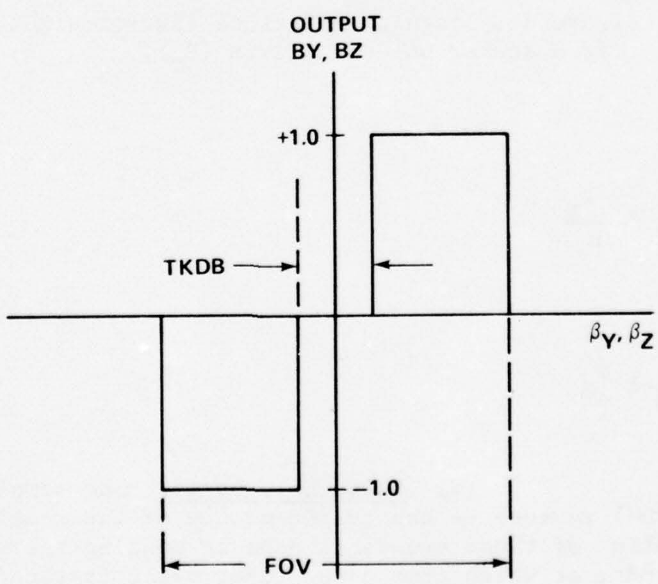


Figure 38. Processor output.

$$BZ = \begin{cases} +1, \text{ if } \beta_Z > 0 \\ -1, \text{ if } \beta_Z < 0 \end{cases} \quad \text{(pitch)}$$

$$BY = \begin{cases} +1, \text{ if } \beta_Y > 0 \\ -1, \text{ if } \beta_Y < 0 \end{cases} \quad \text{(pitch)}$$

In addition to the ±1 output, two instances of zero output are possible. One is due to tracker deadband and the other is due to target moving out of field-of-view limits.

(a) Range Dependent Deadband Determination - Range dependent deadband determination is found using the following equation:

$$TKDB = \left(\frac{BDB}{2}\right)\left(\frac{RANGE}{32810}\right)^2 \quad ,$$

where TKDB is one-half the total range dependent deadband, BDB is the input total deadband normalized to 10 km (32,810 ft), and RANGE is the missile to target slant range. A rationale for computing deadband in this manner is, the reflected laser energy will vary as $1/(RANGE)^2$, so the photoelectric current differential between the four quadrants will also vary as a function of $1/(RANGE)^2$. Since the photoelectric current differential also varies by the amount of image center offset from the detector center, there will be a minimum detectable image offset due to detector and amplifier noise. Therefore, if ($|\beta_Z| <$ TKBD) BZ = 0 and if ($|\beta_Y| <$ TKBD) BY = 0, set pitch or yaw detector outputs to zero if target angular offset in pitch or yaw are within the deadband.

(b) Target In or Out of Field-of-View Determination - The target is out of the elliptical field-of-view defined by Φ_Y and Φ_Z, if

$$\frac{\beta_Y^2}{\Phi_Y^2} + \frac{\beta_Z^2}{\Phi_Z^2} > 1 \quad .$$

The geometry of this determination is shown in Figure 39.

From Figure 39, using small angle approximations (specifically, the Y and Z coordinates of field-of-view and target position are taken to be the arc lengths, e.g., $Y_{FOV} \approx r\,\Phi_Y/57.3$, with angles in degrees), the equation for the field-of-view ellipse boundary is

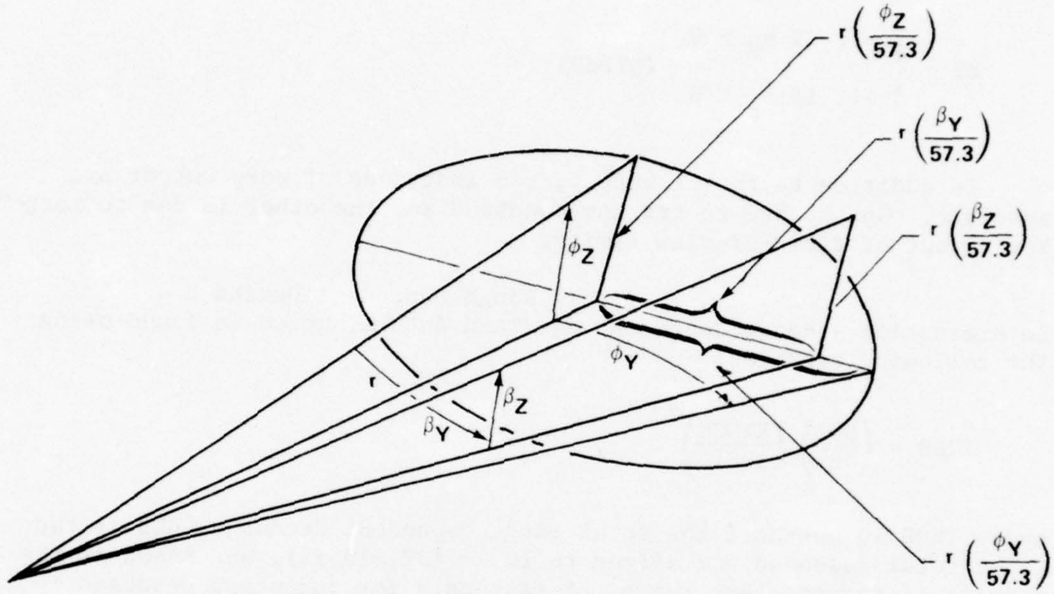


Figure 39. Target in or out of field of view determination.

$$\frac{Y^2}{r^2 \left(\frac{\phi_Y}{57.3}\right)^2} + \frac{Z^2}{r^2 \left(\frac{\phi_Z}{57.3}\right)^2} = 1 \quad .$$

If the point (Y, Z) is such that the left hand side is greater than 1, then (Y, Z) is outside the field-of-view ellipse. Replacing Y and Z with the target components, $r\ \beta_Y/57.3$ and $r\ \beta_Z/57.3$, and cancelling the r's and the 57.3, yields

$$\frac{\beta_Y^2}{\phi_Y^2} + \frac{\beta_Z^2}{\phi_Z^2} > 1 \quad ,$$

the condition for the target being outside the field-of-view.

(4) <u>Direct Fire: Prelaunch Lock-on to Target (OPTN4 = 1)</u>. There are two seeker model options for calculating autopilot and seeker gimbal torque error signals. One option directly outputs the detector error signal times a gain factor. The second integrates the detector gain and permits a seeker signal shaping term

and a response time factor to be input (lead integral compensation). In both of these options, the same signals are used for both the autopilot and the seeker gimbal torque. A third option (platform compensation, which can be exercised only if the second of the previously discussed two options is used) allows the response of the seeker gimbal torque signal to be controlled by input independently of the autopilot signal.

(a) Detector Error Signal Times a Gain Output Directly - Detector error signal times a gain output directly is found using the following equations:

$$\omega_{\lambda Q} = G_s \beta_Z$$

$$\omega_{\lambda R} = G_s \beta_Y$$

$$\omega_{QP} = \omega_{\lambda Q}$$

and

$$\omega_{RP} = \omega_{\lambda R} \quad ,$$

where $\omega_{\lambda Q}$ and $\omega_{\lambda R}$ are the pitch and yaw commands to the autopilot, and ω_{QP} and ω_{RP} are seeker torque commands.

(b) Detector Error Signal Lead Integral Compensation - Detector error signal lead/integral compensation is found using the following equations:

$$\omega_{\lambda Q} = \frac{G_s \beta_Z + \Phi}{\omega_{SL}} + \int_0^t G_s \beta_Z + \Phi \, dt$$

$$\omega_{\lambda R} = \frac{G_s \beta_Y + \Phi}{\omega_{SL}} + \int_0^t G_s \beta_Y + \Phi \, dt$$

$$\omega_{QP} = \omega_{\lambda Q}$$

and

$$\omega_{RP} = \omega_{\lambda R} \quad ,$$

where Φ is an input term which can be used to change the operating level of the detector error signal*, and ω_{SL} is an input seeker signal lead factor.

The block diagram for $\omega_{\lambda Q}$ transformed by the M-method, is shown in Figure 40. An analoguous block represents β_Y.

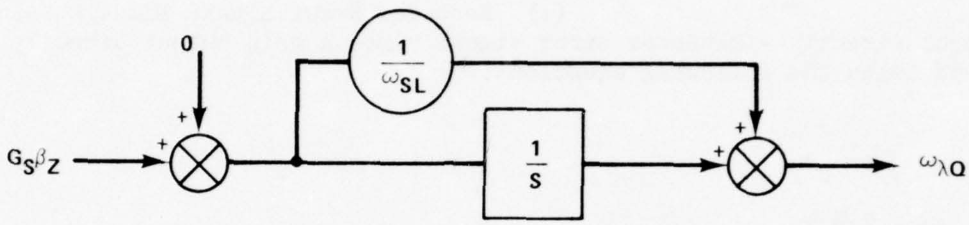


Figure 40. Error signal processing when $\omega_{SL} > 0$.

The pulse hold logic causes β_Z and β_Y to behave as a positive or negative unit step function, depending upon whether the point source target is in the upper or lower two quadrants of the detector. Consequently, the term

$$\frac{G_S \ \beta_Z + \Phi}{\omega_{SL}}$$

is a step function with amplitude $\pm G_S$, when $\Phi = 0$, $\omega_{SL} = 1$. The integrated term is a ramp function with slope $\pm G_S$. The quantity contributed by the term $G_S \ \beta_Z + \Phi/\omega_{SL}$, superimposed on the ramp function, provides the output signal $\omega_{\lambda Q}$ with a faster response to a detector error signal change than would be obtained with only the integrated term.

(c) Platform Compensation (Utilized Only When $\omega_{SN} > 0$) - An additional seeker signal compensation network following the lead integral compensation is optional. The equations for the compensation network are

$$\dot{\omega}_{LQS} = \omega_{SN} \ (\omega_{\lambda Q} - \omega_{LQS})$$

---

*A positive input value of Φ, for example, would cause the detector output signal to ride on the value of $\Phi > 0$, which would positive bias the pitch and yaw error signals to the autopilot. To simulate gyro drift, Φ can be used.

$$\dot{\omega}_{LRS} = \omega_{SN} (\omega_{\lambda R} - \omega_{LRS})$$

and

$$\omega_{QP} = \frac{\dot{\omega}_{LQS}}{\omega_{L2}} + \omega_{LQS}$$

$$\omega_{RP} = \frac{\dot{\omega}_{LRS}}{\omega_{L2}} + \omega_{LRS} \quad .$$

The block diagram for the seeker gimbal torque signals is shown in Figure 41 for the pitch channel (an analogous block can be drawn for the yaro-channel).

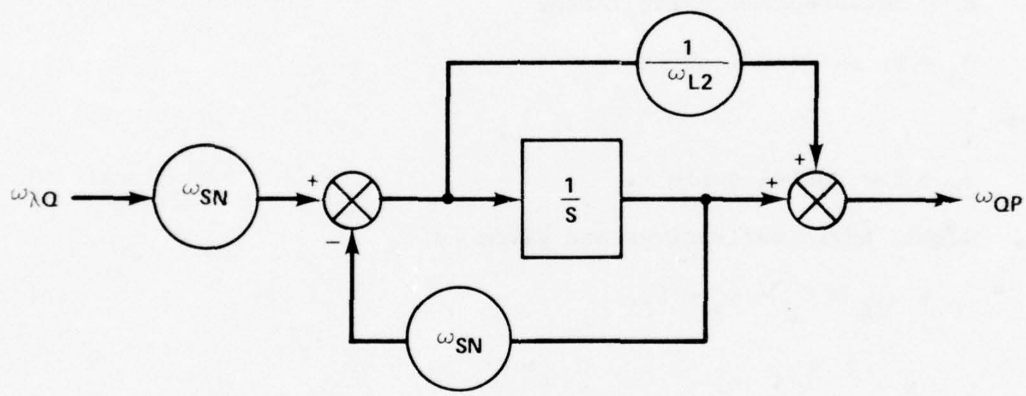


Figure 41. Platform compensation by M-method transformation ($\omega_{SN} > 0$).

(d) Seeker Gimbal Dynamics - After calculation of the seeker error signals for autopilot and seeker gyro gimbal torques, the seeker module transforms missile body rates to the seeker gimbal axes and calculates seeker gimbal angle derivatives. Only first order seeker dynamics such as seeker drift rate and gimbal coupling are considered.

In order to transform missile body rates to seeker gimbal axes

$$\begin{bmatrix} \omega_X \\ \omega_Y \\ \omega_Z \end{bmatrix}_{\text{Gimbal Axes}} = [M]_G \begin{bmatrix} \omega_P \\ \omega_Q \\ \omega_R \end{bmatrix}_{\text{Body Axes}} ,$$

where $[M]_G$ is the body axes to seeker gimbal axes transformation matrix. Because the seeker is not gimballed about the X_B-axis, the ω_X-component is not calculated.

Gimbal coupling terms are given by

$$U_{ZK} = S_\omega (-\theta_G + 0.1\ \psi_G) \quad ,$$

and

$$U_{YK} = S_\omega (-\psi_G - 0.1\ \theta_G) \quad ,$$

where

S_ω = Autoerection drift factor

θ_G = Pitch gimbal angle

and

ψ_G = Yaw gimbal angle .

Gimbal angle derivatives are given by

$$\dot{\theta}_G = \omega_{QP} + C_Z - \omega_Y + S_{DZ}$$

$$\dot{\psi}_G = \omega_{RP} + C_Y - \frac{\omega_Z}{\alpha_{33}} + S_{DY} \quad ,$$

where

S_{DZ}, S_{DY} = Seeker drift rates

α_{33} = The (3,3) element of the body to seeker gimbal axes transformation matrix, M_G.

(5) Indirect Fire: Launch without Lock-on to Target (OPTN4 > 1). In the indirect fire mode, the missile is launched prior to target lock-on. The seeker is caged along the missile longitudinal axis (CAGE = 0), and no signals are processed for output to the autopilot. Thus, the autopilot operates open loop with respect to the seeker. However, the autopilot does operate closed loop about the rate sensor gyros of the autopilot in order to maintain a controlled flight until target acquisition and seeker lock-on. Target acquisition in this case refers to the time that the target comes into the field-of-view, but prior to the time that it crosses the midpoint of the field-of-view in pitch and yaw.

Two events must occur for target acquisition. One, the target must be close enough so that the reflected laser energy is detectable by the seeker. And, two, the target must lie within the field-of-view of the seeker.

When both of these events occur, the acquisition phase is entered. The seeker is then slewed toward the target at a constant rate based on detector output of ± 1 and a high gain, G_{SX}. Thus, pitch and yaw seeker commands are

$$\omega_{QP} = G_{SX} B_Z$$

and

$$\omega_{RP} = G_{SX} B_Y \quad .$$

When the target crosses the centerline of the seeker detector, the slew commands are switched out, the seeker is locked on, and normal tracker operation is begun. At this point, all conditions of direct fire are in effect.

While the seeker is being slewed toward the target, the autopilot remains open loop to the seeker. No autopilot guidance commands are initiated until the target crosses the seeker centerline. When this occurs, the switch TRKZY is set to line to flag the autopilot to commence proportional navigation guidance.

c. Assumptions and Limitations

The following assumptions are made in the 6 DOF seeker model:

1) The target is modeled as a point source.

2) The point source may include motion due to laser designator jitter.

3) The seeker 2 DOF gyro is modeled without second order dynamics.

4) Reflected pulses are always present at the input PRF and are always detected when in the field-of-view.

5) Detector image resolution deadband is a function of range only.

6) The seeker pitch to yaw and yaw to pitch coupling terms assume an inertially stabilized platform.

7) Seeker gimbal angle limiting is not modeled.

8) Numerical integration must be synchronized with sample period [4] (τ at ZOH) in order to insure accurate integration. Logic is built into the seeker subroutines to insure that integration and sample period are synchronized. This is accomplished by

$$\Delta t = \frac{\tau}{\left[\mathrm{AINT}\left(\frac{\tau}{\Delta t_{INPUT}}\right)\right]}$$

where

τ = ZOH sample period (sec)

Δt_{INPUT} = Input integration stepsize (sec)

AINT(X) = Computer function that integerizes the argument (X)

Δt = Integration stepsize that the program will use.

The above function will always compute an integration stepsize that is equal to or greater than the input stepsize. Since there is an upper bound on the stepsize that can be used to integrate the differential equations in this simulation program, there is the possibility that a stepsize larger than the upper bound will be computed. (Upper bound is approximately 12.5 msec, with the exception of the optical contrast seeker model S2 which has an upper bound of approximately 0.5 msec). Therefore, one should insure that a reasonable stepsize is input and verify that a reasonable stepsize is computed. For example, if the sample period is 16.7 msec, then a stepsize of 8.35 msec or less must be input to insure that the computed stepsize is 12.5 msec or less.

The first assumption results in all of the seeker optics and detector characteristics (such as image resolution, saturation, signal-to-noise, etc.) being ignored. The implications of the third assumption are essentially self-explanatory; the simulated gyro behaves as a perfect gyro (with the exception of the coupling terms and drift). The fourth and fifth assumptions ignore the possibility of lost pulses, attenuation of reflected signals due to atmospheric conditions designator malfunction, countermeasures, etc. The sixth assumption is not strictly true in a gyro which is processed to follow the line-of-sight. However, the assumption would not be severely violated with a relatively stabilized line-of-sight seeker boresight angle. If the 6 DOF model is to be used to evaluate candidate seekers components (e.g., seekers) however, more precise models may be required.

d. Initialization Subroutine

The seeker initialization subroutine, S1I, enters the indices of the elements of the C-array which contain seeker module generated derivatives into successive locations in the IPL array. The IPL-array points the numerical integration logic to the elements of the C-array which are to be numerically integrated. S1I initializes the IPL-array with the indices of all potentially utilized seeker related derivatives, despite the fact that the number of derivatives actually used by the seeker module depends upon whether the input values of the variables ω_{SL} and ω_{SN} are zero or positive. The only potentially detrimental effect of this is to cause unnecessary numerical integrations to occur.

S1I initializes the cage-uncage switches used in S1 as a function of the setting of the input option switch, OPTN4. Specifically, if OPTN4 $\leq$ 1 (signifying that simulation is for direct fire, lock-on before launch), the seeker gyro caging switches are set to the uncaged value (CAGE, TKRY, TKRZ, and TRKZY all equal to 1), reflecting the fact that the gyro is uncaged before direct fire launch. If OPTN4 > 1 (an indirect fire mode simulation), the seeker gyro caging switches are set to the cage value, zero.

S1I also provides initial values for several Monte Carlo variables including seeker output starting values BY and BZ, seeker starting time ST, seeker pointing error θ_{ERR} and ψ_{ERR}, and seeker drift S_{DY} and S_{DZ}.

e. Random Error Sources

(1) Seeker Pulse Train. The seeker output signal starting time (ST) and initial output value in the pitch (BZ) and yaw (BY) channels are initialized through calls to MCARLO in the seeker initialization module, S1I.

The seeker output is a bang-bang signal similar to that shown in Figure 42. Therefore, the absolute magnitude of this signal does not change the probability distribution for the initial value of the seeker signal represents only the probability of the sign of the signal. Thus, initial values of BY and BZ are determined from a distribution according to the sign of the random number.

(2) Seeker Pointing Error. The seeker gimbal yaw angle ψ_G and the seeker gimbal pitch angle θ_G are initialized through calls to MCARLO in the seeker initialization module, S1I.

(3) Seeker Drift. Two elements of seeker drift are modeled. They are on-axis and autoerection drift. The equation for these drift elements, in the yaw and pitch channels, are

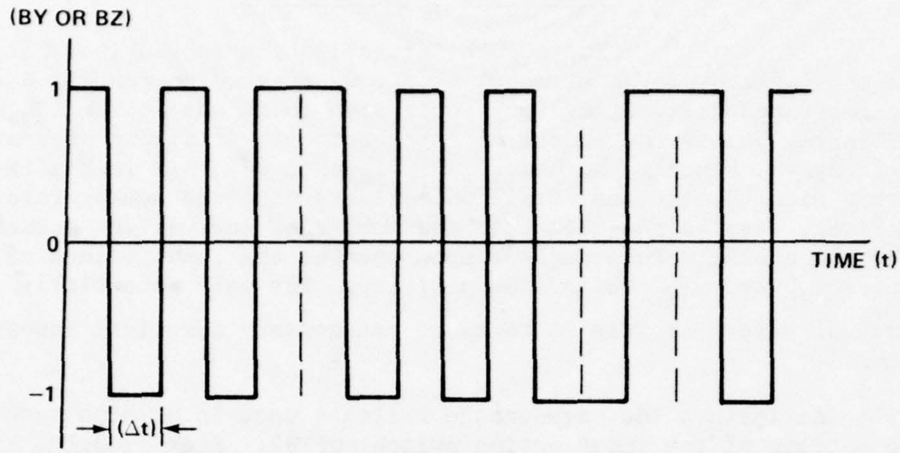


Figure 42. Seeker pulse train.

$$U_{ZK} = S_{\omega} (-\theta_G + 0.1\ \psi_G) + S_{DZ}$$

and

$$U_{YK} = S_{\omega} (-\psi_G - 0.1\ \theta_G) + S_{DY} ,$$

where

S_{ω} = Autoerection drift coefficient

S_{DY} = On axis drift in yaw

S_{DZ} = On axis drift in pitch.

f. Input/Output Variables and Cross Reference of C-Array

The input/output variables and cross reference of C-array for module S1 are presented in Tables 43, 44, and 45.

g. Monte Carlo Input Variables and Cross Reference of C-Array

The Monte Carlo input variables and cross reference of C-array for module S1 are presented in Table 46.

h. Other Available Seeker Models

Three optional seeker models are available to the Monte Carlo 6 DOF program. They are obtained by dropping the S1

TABLE 43. INPUT FROM DATA CARDS - MODULE S1

Fortran Symbol	Symbol Used in Text	C Index	Definition
RLOCK	RLOCK	445	Maximum quadrant tracker acquisition range (ft)
DT	Δt	446	Laser designator pulse repetition time (sec)
BDB	BDB	447	Tracker deadband (deg) at 10 km
CFOVZ	Φ_Z	448	Total seeker field-of-view in pitch (deg)
CFOVY	Φ_V	449	Total seeker field-of-view in yaw (deg)
GSX	G_{SX}	450	Seeker acquisition slew command rate (deg/sec)
SEPS	Φ	451	Integration shift rate
SWP	S_ω	452	Autoerection drift
GS	G_S	456	Detector output gain (deg/sec)
WSL	ω_{SL}	457	Lead integral compensation zero (rad/sec)
WSN	ω_{SN}	458	Platform compensation pole (rad/sec)
WL2	ω_{L2}	459	Platform compensation zero (rad/sec)

type 2 input card and adding a new type 2 card for the desired seeker model. The three models are listed as follows:

1) Optical contrast seeker - S2 module [2].

2) Optical contrast seeker, low frequencies only - S3 module [2].

3) Digital/linear laser seeker - S4 module [5].

Each of the three modules has a module number to be punched right-adjusted in column 25 of its type 2 card. They are S2-29, S3-30, and S4-31. These numbers control which module is called.

TABLE 44. INPUT FROM OTHER MODULES - MODULE S1

Fortran Symbol	Symbol Used in Text	C Index	Definition
RANGE	RANGE	371	Missile to target slant range (line-of-sight vector magnitude) (ft)
RXBA	X_B	372	X-component of slant range (in body axes) (ft)
RYBA	Y_B	373	Y-component of slant range (in body axes) (ft)
RZBA	Z_B	374	Z-component of slant range (in body axes) (ft)
WP	ω_P	1739	Missile roll rate (in body axes) (deg/sec)
WQ	ω_Q	1737	Missile pitch rate (in body axes) (deg/sec)
WR	ω_R	1747	Missile yaw rate (in body axes) (deg/sec)
SDY	S_{DY}	465	Yaw on axes drift rate (deg/sec)
SDZ	S_{DZ}	466	Pitch on axes drift rate (deg/sec)

TABLE 45. OUTPUTS - MODULE S1

Fortran Symbol	Symbol Used in Text	C Index	Definition
WLAMQ	$\omega_{\lambda Q}$	403	Seeker pitch error signal to autopilot
WLAMR	$\omega_{\lambda R}$	407	Seeker yaw error signal to autopilot
CAGE	CAGE	461	Seeker gyro cage-uncage switch
TKRZ	-	462	Acquisition switch for pitch
TKRY	-	463	Acquisition switch for yaw
TRKZY	-	464	Acquisition switch for autopilot

TABLE 45. (Concluded)

Fortran Symbol	Symbol Used in Text	C Index	Definition
BY	BY	11	Seeker processor output value in yaw (deg)
BZ	BZ	12	Seeker processor output value in pitch (deg)
BEPSZ	β_Z	435	Boresight angle in pitch (deg)
BEPSY	β_Y	436	Boresight angle in yaw (deg)
WZ	ω_Z	437	Missile body rates in gimbal axes
WY	ω_Y	438	
BGDEFL		439	Total deflection of gimbals
WLQD		408	Seeker state variables
WLZ		411	
WLRD		412	
WLR		415	
WLQDS		416	
WLQS		419	
WLRSD		420	
WLRS		423	
BTHTGD	$\dot{\theta}_G$	424	Pitch gimbal angle rate (deg/sec)
BTHTG	θ_G	427	Pitch gimbal angle (deg)
BPSIGD	$\dot{\psi}_G$	428	Yaw gimbal angle rate (deg/sec)
BPSIG	ψ_G	431	Yaw gimbal angle (deg)

Included in Sections III.B.12.i , III.B.12.j , and III.B.12.k are the random error sources, input/output variables, and Monte Carlo input variables for each model. Complete documentation of each seeker model can be found in the references [1-9].

i. Random Error Sources

(1) S2 and S3 Module Optical Contrast Seeker. Initial condition random error sources specified as probability distributions unique to the optical contrast seeker or impacting the operation of the optical contrast seeker are listed as follows.

TABLE 46. MONTE CARLO INPUT - MODULE S1

Program Variable Name of Error Source	C Index of Error Source	Program Module Calling MCARLO	MCARLO Flag*		Definition
			Name	Index	
ST	460	S1I	ST	460	Seeker starting time
BY	11	S1I	BY	11	Seeker output initial value in yaw
BZ	12	S1I	BZ	12	Seeker output initial value in pitch
UYK		S1I	SWP	452	Autoerection drift
UZK		S1I	SWP	452	Autoerection drift
UYK		S1I	SDY	465	On-axis drift
UZK		S1I	SDZ	466	On-axis drift
BTGERR	470	S1I	BTGERR	470	Yaw gimbal angle pointing error
BPGERR	471	S1I	BPGERR	471	Pitch gimbal angle pointing error

*MCARLO is flagged by the C-index of this variable in the calling module.

When MCARLO is flagged by this C-index, a random number will be returned from MCARLO for the error source in the first column.

a) Seeker platform mass unbalance -

(1) Outer gimbal.

(2) Inner gimbal.

b) Seeker rate gyro errors -

(1) Drift.

(2) Mass unbalance.

(3) Output axis/missile roll coupling.

c) Launch transient rate distributions -

(1) Pitch and yaw rate.

(2) Roll rate.

(2) S4 Module Digital/Linear Laser Seeker. Initial condition and time varying error sources specified as probability distributions relating to the digital/linear seeker are as follows:

a) Seeker drift.

b) Seeker pulse train.

c) Laser designator spot jitter.

d) S/T ratio uncertainties.

e) Seeker gain variations.

j. Input Variables and Cross-Reference of C-Array

(1) Optical Contrast Seeker, Module S2 and S3 Input Variable Description. Tables 47 and 48 identify all variables of the optical contrast seeker subroutines (S2 and S3) that can be input by 3-cards. Variable names beginning with K are the gains. Variable names beginning with W are the frequency components.

TABLE 47. INPUT FROM DATA CARDS - MODULE S2 AND S3 (OPTICAL CONTRAST SEEKER)

Fortran Symbol	Symbol Used in Text	C Index	Definition
WTQ1		573	Pitch channel frequencies
WTQ2		575	
WGQ1		577	
WGQ3		581	
WGQ4		583	
WGQ5		585	
WGQ6		587	
WRQ2		591	
WRQ4		595	
WTR1		574	Yaw channel frequencies
WTR2		576	
WGR1		578	
WGR3		582	
WGR4		584	
WGR5		586	
WGR6		588	
WRR2		592	
WRR4		596	
RCL		597	Rate command limit in pitch and yaw
TCLQ		598	Torque command limit in pitch

TABLE 47. (Continued)

Fortran Symbol	Symbol Used in Text	C Index	Definition
TCLR		599	Torque command limit in yaw
JI		565	Moment of inertia of inner gimbal
JO		566	Moment of inertia of outer gimbal
GEOCS		497	Rate gyro gain to autopilot, pitch and yaw
FRI		567	Inner gimbal friction coefficient (in.-oz)
FRO		568	Outer gimbal friction coefficient (in.-oz)
FFOV		604	Blind range decimal percent field-of-view
TARHT		601	Target height (ft)
TARWD		602	Target width (ft)
TAU		600	Seeker sample period (sec)
TLAG		606	Optical contrast seeker transport lag (sec)
KQ1 KQ2 KQ3 KQ6 KQ7 KQ8 KQ10 KQ11 KQ12		545 547 549 553 555 557 559 561 563	Pitch channel gains
KR1 KR2 KR3 KR5 KR6 KR7 KR8 KR10 KR11 KR12		546 548 550 552 554 556 558 560 562 564	Pitch channel gains

TABLE 47. (Concluded)

Fortran Symbol	Symbol Used in Text	C Index	Definition
WPTO		1738	Tipoff roll rate (deg/sec)
AMP2		1742	Peak amplitude of pitch moment forcing function (ft/lb)
AMP1		1746	Peak amplitude of yaw moment forcing function (ft/lb)
VIB		626	Launch transient vibration flag (pitch and yaw only): 0 - no vibration 1 - run with vibration

TABLE 48. INPUT FROM DATA CARDS - MODULE S4 (DIGITAL/LINEAR LASER SEEKER)

Fortran Symbol	Symbol Used in Text	C Index	Definition
DT		446	Laser designator pulse repetition rate (sec)
GS		456	Detector output gain
SEPS		451	
SWP		452	Spring restraining torque constant
WSL		457	Lead integral compensation zero (rad/sec)
WSN		458	Platform compensation pole (rad/sec)
WL2		459	Platform compensation zero (rad/sec)
CROSS		506	Gimbal cross coupling coefficient
BLUR		519	Diameter of laser spot on seeker detector (deg)
CKNULL		523	Proportionality constant of θ null

TABLE 48. (Concluded)

Fortran Symbol	Symbol Used in Text	C Index	Definition
STOTSW		524	Digital to linear switching point
STOTMX		525	Detector output limiter (deg/sec)
RDES		526	Designator range (ft)
HDES		527	Designator altitude (ft)
RVIS		529	Visibility (statute mi)
CPT		530	Target reflectivity
ETHR		531	Threshold energy density at seeker aperture (J/km^2)
EDES		532	Laser designator energy (J)
WCZ		500	Guidance filter natural frequency (rad/sec)
WF		502	
BF		505	
CZETA		507	Guidance filter damping coefficient
SGBIAS		509	Seeker g-bias (deg/sec)
WCN		518	Guidance filter pole (rad/sec)
WCL		510	Guidance filter zero (rad/sec)
SGSTOT		511	Standard deviation of S/T ratio (dB)
GSLIM		539	Seeker output rate limits for linear operation

k. <u>Monte Carlo Input Variables and Cross Reference of C-Array</u>

(1) <u>Optical Contrast Seeker Monte Carlo Input Variables</u>. The variables associated with the Monte Carlo seeker models are given in Table 49. The mean values of these variables are input by 3-cards and the probability distributions are input by 8-cards.

(a) Launch Transient Monte Carlo Input Variables, Optical Contrast Seeker Modules - An 8-card is used to select any one of these models (roll, pitch, or yaw) as a Monte Carlo variable. Roll is the only one of the three that requires specification of a probability distribution on the 8-card. The pitch and yaw models do require 8-cards; however, the probability distribution input fields are left blank because pitch and yaw are randomized indirectly.

A mean value of roll rate (WPTO) is input by 3-card. Mean values of pitch and yaw rate are not input because the mean and distribution of these two variables are determined from solution of the forcing function, F(t) [2]. However, the peak amplitude of pitch (AMP2) and yaw (AMP1) moment (due to helicopter vibration) must be input by 3-card. In addition, the flag, VIB, must be input equal to 1.

(b) Pitch and Yaw Randomization Independent of Launch Transient Model - Pitch and yaw tipoff rates may be randomized from an input probability distribution via the C-indices of pitch and yaw rate on an 8-card. This capability was added as an option to directly randomize as opposed to indirectly randomizing pitch and yaw rates as previously mentioned. Use of this option will generate instantaneous changes in pitch and yaw rate at time of rear shoe rail exit. This option was added primarily to allow randomization of pitch and yaw rates for launch from a tower or ground vehicle in which there are not launcher vibrations. However, this option can be exercised simultaneously with the previously mentioned vibration model. The roll rate randomization previously described applies equally to helicopter or ground launchers.

(2) <u>Digital/Linear Laser Seeker Monte Carlo Inputs</u>. Table 50 presents the digital/linear laser seeker Monte Carlo inputs for module S4.

13. SPOT - Laser Designator Spot Jitter

a. <u>Functional Description</u>

The spot jitter module computes the Y and Z components of the laser designator spot motion (jitter) on the target plane. It also sets up the spot jitter derivatives to be integrated for the next time step.

TABLE 49. MONTE CARLO INPUT - MODULES S2 AND S3 (OPTICAL CONTRAST SEEKER)

Program Variable Name of Error Source	C Index of Error Source	Program Module Calling MCARLO	MCARLO Flag*		Definition
			Name	Index	
KUO	611	S2I		611	Outer gimbal mass unbalance (in.-oz/g)
KUI	612	S2I		612	Inner gimbal mass unbalance (in.-oz/g)
KBO	613	S2I		613	Outer gimbal drift rate (deg/sec)
KBI	614	S2I		614	Inner gimbal drift rate (deg/sec)
KOAO	617	S2I		617	Outer gimbal output axis/roll coupling coefficient (sec)
KOAI	618	S2I		618	Inner gimbal output axis/roll coupling coefficient (sec)
WPTO	1738	A3I, A2		1738	Mean tipoff roll rate (deg/sec)
AMP2	1742	A3I, A2		1742	Peak amplitude of pitching moment forcing function (ft/lb)
AMP1	1746	A3I, A2		1746	Peak amplitude of yawing moment forcing function (ft/lb)
WQ	1743	A2		1743	Pitch rate (deg/sec)
WR	1747	A2		1747	Yaw rate (deg/sec)

*MCARLO is flagged by the C-index of this variable in the calling module.

When MCARLO is flagged by this C-index, a random number will be returned from MCARLO for the error source in the first column.

TABLE 50. MONTE CARLO INPUT - MODULE S4 (DIGITAL/LINEAR LASER SEEKER)

Program Variable Name of Error Source	Program Module Containing Error Source	Program Module Calling MCARLO	MCARLO Flag*		Definition
			Name	Index	
UYK	S4	S4I	SWP	452	Autoerection drift
UZK					
UYK	S4	S4I	SDY	465	On-axis drift
UZK	S4	S4I	SDZ	466	On-axis drift
ST	S4	S4I	ST	460	Seeker starting time
BEPSY	S4	S4I	BEPSY	436	Seeker initial pointing error in yaw
BEPSZ	S4	S4I	BEPSZ	435	Seeker initial pointing error in pitch
GS	S4	S4, S4I	GS	456	Seeker output gain
GSLIM	S4	S4, S4I	SGLIM	539	Seeker output rate limit

*MCARLO is flagged by the C-index of this variable in the calling module.

When MCARLO is flagged by this C-index, a random number will be returned from MCARLO for the error source in the first column.

b. <u>Equations</u>

To simulate designator jitter, white noise is passed through the second order filter shown in Figure 43. The result is a correlated output that closely approximates involuntary human movement. The damping factor, ζ, and the natural frequency, ω_0, are chosen such that the output of the filter matches that movement. These values are built into the model. The gain G of the filter is selected by the user to control the standard deviation of the output.

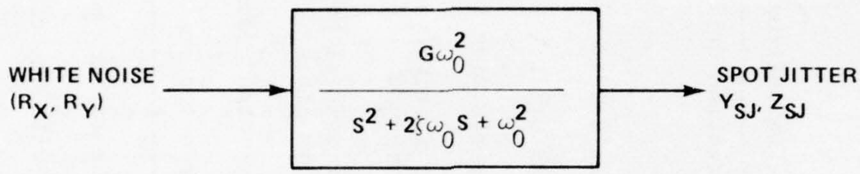


Figure 43. Spot jitter filter.

The spot motion is assumed to be in the target plane as shown in Figure 44 and is composed of two parallel but independently computed components in Y and Z. Two identical filters are used to compute these two components. The output of these two filters at any instant in time is different because a different white noise signal is input to each.

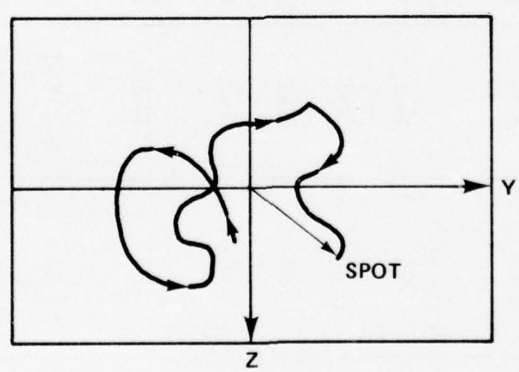


Figure 44. Spot trace in target plane.

The differential equation derived from the transform (Figure 43) to be numerically integrated is

$$X + 2\zeta\omega_0 X + \omega_0^2 X = \omega_0^2 R_X \quad .$$

The actual spot position Y-component (similarly for Z) is:

$$Y = GX$$

where the gain G is

$$G = 0.707 \frac{\sigma_{SPOT}}{\sqrt{\frac{\omega_0 \Delta t}{4\zeta}}}$$

The parameters in the previously mentioned equations are

ζ = Damping factor (0.745 data statement in SPOTI)

ω_0 = Natural frequency (3.94 data statement in SPOTI)

R_X = White noise input to Y-component filter

σ_{SPOT} = Expected standard deviation of RSS output of both Y and Z component filters (the 0.707 appears because σ_{SPOT} is the RSS standard deviation)

Δt = Random number calling sequence (normally the integration stepsize)*.

The filter integration constants are all initialized to zero on the first run of a run set. On all subsequent runs of that run set, the filter is not reinitialized, but instead remains charged with the final values that occurred on the preceding run. This means that the time series output is a continuously varying function interrupted by neither reinitialization of all deterministic parameters nor randomization of the stochastic parameters. For example, assume a seven run set in which the flight time of each run is 2 sec. The combined run set flight is then 14 sec. If a plot of the spot jitter were made versus the combined flight time. It would appear as shown in Figure 45. Each 2-sec time slice would represent the spot motion that occurred in each individual run of the run set.

---

*The statistical properties of the output filter will vary ±10% when the integration step is varied from 0.01 to 0.0125 sec. Therefore, care must be exercised in changing the integration stepsize when performing sensitivity studies.

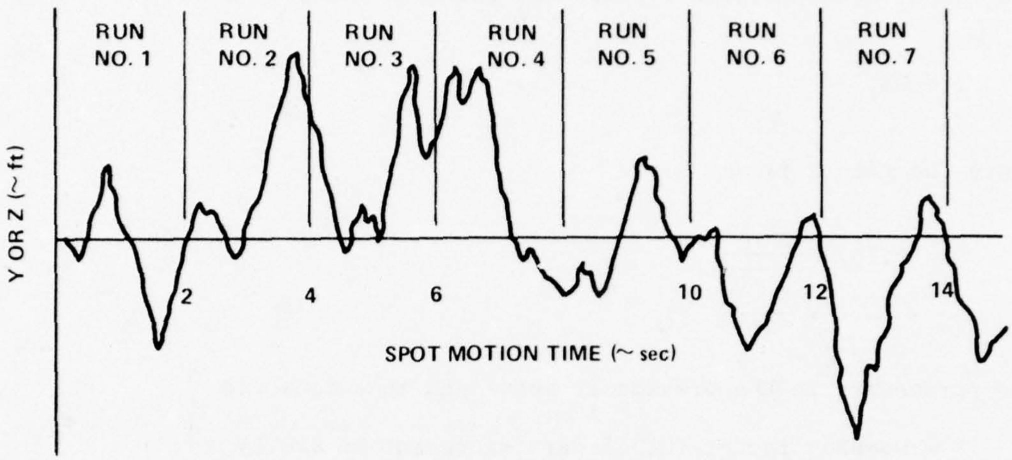


Figure 45. Spot jitter time history.

The reason for handling spot jitter in this manner was to eliminate the transient response of the spot from all runs after the first. The transients die down in approximately 3 to 4 sec. Thought was also given concerning the running of the spot jitter filters for a period of 10 to 15 sec prior to beginning the first run of the set to eliminate the transients from all runs. However, since the minimum spot motion run time for a 25 Monte Carlo run set is approximately 90 sec (3.5 sec per run for a 1-km missile range), the transient response of the filter did not last long enough nor did it appear serious enough to warrant consideration.

A final word about MCARLO and its treatment of spot jitter. This particular error source is handled such that the missile guides on the spot, but calculates miss distance from the target. This was accomplished by adding the spot position to the seeker line-of-sight vector (in G5) so that it guides on the spot.

c. Initialization Subroutine

SPOTI is the initialization subroutine for SPOT. The components of spot jitter (Y_{SJ}, Z_{SJ}) and the spot jitter scale factors (GSPOTY and GSPOTZ) are initialized in SPOTI. Also, the logic to add the spot jitter differential equations to the array (IPL) of the 6 DOF program is contained therein. IPL is the array of variables to be integrated each time step.

d. Random Error Sources

Spot jitter Y and Z components are the only random error sources in SPOT.

e. <u>Input/Output Variables and Cross Reference of the C-Array</u>

Tables 51, 52, and 53 present the input/output variables and cross reference of the C-array for module SPOT.

TABLE 51. INPUT FROM DATA CARDS - MODULE SPOT

Fortran Symbol	Symbol Used in Text	C Index	Definition
SIGSPOT	T_{SPOT}	1581	Expected standard deviation of spot jitter RSS value in Y and Z) (ft)
ZETA	ζ	1579	Spot jitter filter damping rates
WO	ω_0	1580	Spot jitter filter natural frequency (rad/sec)

TABLE 52. INPUT FROM OTHER MODULES - MODULE SPOT

Fortran Symbol	Symbol Used in Text	C Index	Definition
ITNDX		3753	Array of Monte Carlo C-indices input on 8-cards
ITCT		3721	Total number of time series error sources
RX	R_X	1561	White noise input to Y-component filter
RY	R_Y	1571	White noise input to Z-component filter
GSPOTY	G	1562	Spot jitter Y-component scale factor
GSPOTZ	G	1572	Spot jitter Z-component scale factor

f. <u>Monte Carlo Input Variables and Cross-Reference of C-Array</u>

Table 54 presents the Monte Carlo input variables and cross reference of C-array for module SPOT.

TABLE 53. OUTPUT MODULE SPOT

Fortran Symbol	Symbol Used in Text	C Index	Definition
SXPDD	$\ddot{X}$	1560	Spot jitter differential equation variables
SYPDD	$\ddot{Y}$	1570	
SXPD	$\dot{X}$	1563	
SYPD	$\dot{Y}$	1573	
SXP	X	1566	
SYP	Y	1576	
RSJYMC	$Y_{S\sigma}$	1680	Y-component of spot in target plane (ft)
RSJZMC	$Z_{S\sigma}$	1681	Z-component of spot in target plane (ft)

TABLE 54. MONTE CARLO INPUT - MODULE SPOT

Program Variable Name of Error Source	C Index of Error Source	Program Module Calling MCARLO	MCARLO Flag*		Definition
			Name	Index	
RSJYMC	1680	SPOT SPOTI	RSJYMC	1680	Y-component of spot jitter
RSJZMC	1681	SPOT SPOTI	RSJZMC	1681	Z-component of spot jitter
SIGSPOT	1581				Expected standard deviation of spot jitter. Must be input on type 3 data card

*MCARLO is flagged by the C-index of this variable in the calling module.

When MCARLO is flagged by this C-index, a random number will be returned from MCARLO for the error source in the first column.

C. MCARLO-Monte Carlo Control Subroutine

1. Introduction

A Monte Carlo approach was developed for generating CEP related information for the THAD program. This approach consists of executing a specified number of runs* using the MICOM 6 DOF simulation program, where both initialization error conditions and time varying error conditions for each simulation run will be randomly generated from input error probability distributions. The resulting miss distance coordinates from each run are then subjected to an automated statistical analysis using the CEP Analysis System (CEPAS) program, Section III. D to obtain CEP information.

The composite simulation tool that evolved from the Monte Carlo approach is a stochastic 6 DOF model consisting of the MICOM 6 DOF deterministic simulation program, a Monte Carlo control subroutine (MCARLO), and the CEPAS program.

Statistical data are input on distinct data card types (type 8 cards). In the absence of statistical data inputs, the operation of the 6 DOF program reverts to that of the deterministic version of the program.

The Monte Carlo approach takes advantage of the dual mode operation of the 6 DOF program. The initialization modules call MCARLO to randomize all initial condition error sources. Then in the flight execution module, MCARLO is called to generate time series random conditions.

2. Monte Carlo Control Subroutine - MCARLO

The Monte Carlo control subroutine MCARLO is structured according to error source type and error source probability distribution. There are two error source types. They are initial condition error sources and time varying error sources. There are three error source distributions. They are normal, uniform, and correlated normal. The error source distributions are subcategories of both error source types as shown in Figure 46 with the one exception of correlated normal which is unique to time series error sources.

If no stochastic input data cards are read on input, the local error source logic which calls MCARLO (necessarily located at the point of application of the error source in the 6 DOF program) is step up so that the call is not executed.

---

*A run is defined as the numerical integration of a missile trajectory from launch to target plane intercept.

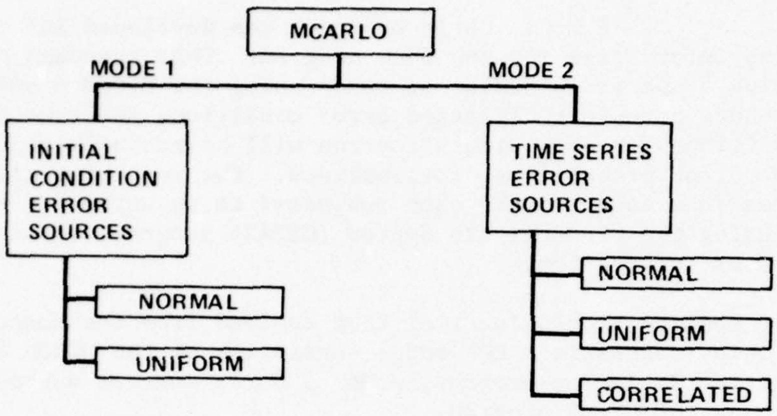


Figure 46. MCARLO structure.

3. MCARLO Operational Modes

Subroutine MCARLO has four modes of operation. The mode to exercise depends upon the location in the 6 DOF program from which MCARLO is called and the type of error source. The mode is identified by number in the argument list of the MCARLO call statement, i.e.,

MCARLO (RNSTRT, MODE, ITSNDX) .

a. <u>MODE = -1. Initial Condition Heading Print Mode</u>

MCARLO is called from MAIN to write the following heading and column names at the start of each run initialization:

MONTE CARLO INITIAL CONDITIONS
C-INDEX MC-VALUE MEAN DISTRIBUTION LOWER BOUND UPPER BOUND

b. <u>MODE = 1. Initial Condition Error Source Mode</u>

MCARLO is called from an initialization module under this mode. This mode flags MCARLO to randomize an initial condition error source from a user specified probability distribution. Mode 1 also provides for the storage of user input error source mean values on the first run of a run set. This allows the mean of the error source to remain fixed for all subsequent runs. Thus, all Monte Carlo values for a given error source will be about the original mean values for all runs of the run set.

c. MODE = 2. Time Series Mode

MCARLO is called from the flight simulation modules under this mode. Mode 2 flags MCARLO to generate random numbers for a time series error source based on user specified sample intervals* and probability distributions. The sample intervals can range from a lower bound of the integration stepsize to an upper bound of the flight time itself. The sampling can be pure periodic or random normally distributed with user control over both the periodic mean and standard deviation. (Protective logic is included to ensure that the period always advances but never advances beyond twice the mean of the period.) When MCARLO is called by mode 2, it first checks the flight time against the next time series sample time. If the sample time has been reached, it sets up the next sample time (either periodic or random, as determined by input option), and generates a new random value for the error source, then returns control to the calling routine. This procedure is repeated for each time series error source at each integration step.

d. Mode = 4. Time Series Initialization Mode

MCARLO is called from the initialization modules under a mode 4 to initialize the following pertinent time series error source parameters in MCARLO:

1) Reset the time series sampling time (TNXST) to zero at the start of each new run.
2) Save the time series error source means for normally and uniformly distributed error sources.
3) Initialize the time series error source variables associated with correlated normal output.

4. MCARLO Error Probability Distribution

Subroutine MCARLO has three error source probability distributions. The distribution to use depends upon user specified input data. Each distribution is identified by number in the following manner:

0 - Normal distribution
1 - Uniform distribution
2, 3, 4 } Correlated normal distribution*.

*Each of the three different numbers in the correlated normal distribution category identifies a specific parameter in the 6 DOF program that is a correlated random variable. More information on this in the input section.

a. Normal Distribution

Normally distributed error source values are picked from the system library random number generator based on user specified normal distribution parameter values indicated in Figure 47.

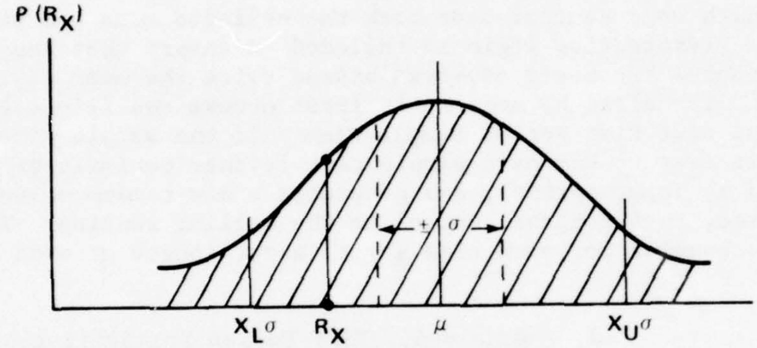


Figure 47. Normally distributed error source.

The distribution parameters, mean (μ), standard deviation (σ), and cutoff values (σX_L and σX_U) are specified on input data cards. The limits (X_L and X_U) are multiples of the standard deviation (σ). For instance, assume a standard deviation of 2 ft, a mean of 0, and limits of $\pm$ 6 ft; the input values of X_L and X_U would be

$$X_L = -3$$

and

$$X_U = 3 \quad .$$

b. Uniform Distribution

Uniform distributed error source values are picked from the system library random number generator based upon user specified uniform distribution parameter values indicated in Figure 48. The input format for a uniformly distributed error source is identical to that for a normally distributed error source so that the standard deviation for a uniformly distributed error source would be utilized in a manner analogous to its interpretation for a normally distributed error source.

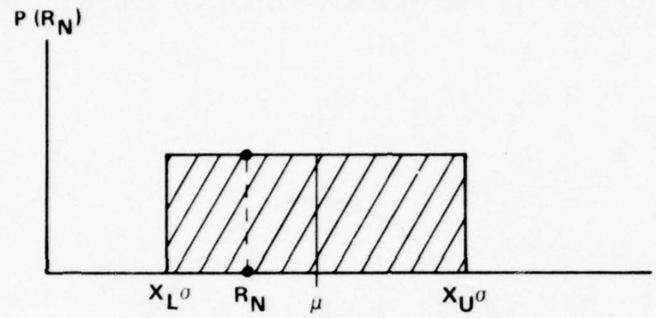


Figure 48. Uniformly distributed error source.

The random number, R_N, returned by MCARLO is computed from the following eauation where R_X is the random number generated by the system library random number generator from the distribution shown in Figure 49.

$$R_N = \mu + (R_X(X_U - X_L) + X_L)\sigma \quad .$$

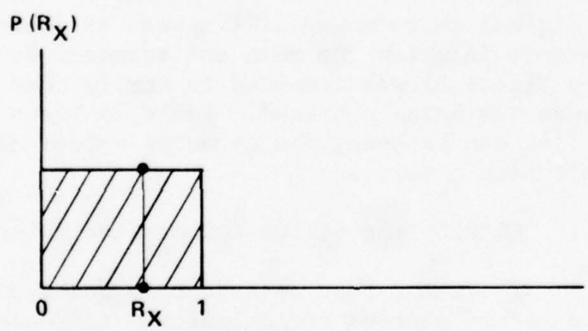


Figure 49. System library random number distribution.

c. Correlated Normal Distribution

The correlated normal distribution involves the generation of digital white noise to be used as the forcing function in an nth order filter to produce a random but correlated output. An example of nth order filters used in the Monte Carlo program is given in Section III. B. 13. The digital white noise is produced by calling the system library normally distributed random number generator.

The distribution parameter values shown in Figure 47 used to produce the white noise is given in Figure 50. The output from the digital white noise generator is sampled and held with the hold period ($N\Delta T$) specified by input.

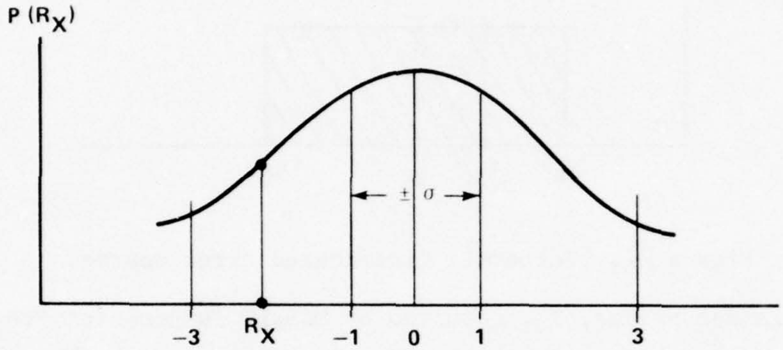


Figure 50. Expected digital white noise distribution.

The random number generator is called only at the beginning of an integration step; therefore, the calling frequency must be input as multiples of the 6 DOF program integration stepsize. No random numbers are generated during the intermediate Runge-Kutta passes.

The output digital white noise will appear as shown in Figure 51. Sample runs were made in which the mean and standard deviation of an output similar to Figure 51 was computed to verify that something near the expected values was being obtained. Table 55 lists the results of this sample run. As can be seen, the computed values match very closely with the expected values.

5. MCARLO Time Series Output Statistical Information

The mean, root mean square, and standard deviation of all time series error sources are calculated for each run of a run set and printed out at the end of each run. A sample of this printed output is given in the following listing:

C-Index	Mean	Variance	Standard Deviation	RMS
1688	0.311	0.415	0.644	0.715
1681	0.219	0.217	0.465	0.514
70	20.814	18.960	4.354	21.265

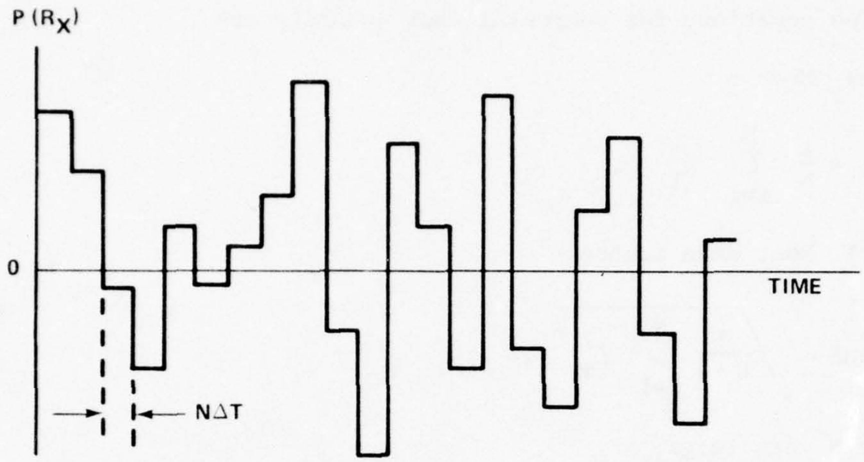


Figure 51. Digital white noise.

TABLE 55. WHITE NOISE MEAN AND STANDARD DEVIATION

NBR Points	Mean	Standard Deviation
4	0.33906	1.05079
8	0.12430	0.94270
12	0.32426	0.97609
16	0.18078	0.92107
20	0.06838	1.07162
24	0.03911	1.01745
28	0.11203	1.02958
32	0.12258	0.99166
36	0.18264	0.97269
40	0.13704	0.96311
44	0.01243	1.02618
48	0.06378	1.04694
52	0.00576	1.06904
56	0.02060	1.03755
60	0.04752	1.01945
64	0.07061	1.07774
68	0.03115	1.08620
72	0.05118	1.07271
76	0.07003	1.05797
80	0.08658	1.08227
84	0.07411	1.05841
88	0.08188	1.04525

The equations for computing each quantity are

a) Mean -

$$\mu = \frac{1}{N} \sum_{i=1}^{N} X_I \quad .$$

b) Root mean square -

$$RMS = \sqrt{\frac{1}{N-1} \sum_{i=1}^{N} X_i^2} \quad .$$

or for N very large,

$$RMS = \sqrt{\frac{1}{N} \sum_{i=1}^{N} X_i^2} \quad .$$

c) Standard Deviation

$$\sigma = \sqrt{RMS^2 - \mu^2} \quad .$$

6. Addition of New Error Source Models

The addition of new error source models to the 6 DOF program is described in the following paragraphs. The procecure required depends upon whether the error is an initial condition error source or a time series error source. In addition, the complexity of time series error source addition depends upon whether the probability distribution of the time series error source is normal, uniform, or correlated normal. The correlated normal time series error source is the more complex model because it involves filtered white noise.

a. <u>Initial Condition Error Sources</u>

Initial condition error modeling will always appear in one of the initialization modules. The module in which the source is modeled depends upon the point of application of the error source in the missile system. For example, an error source assoicated with the seeker will logically be modeled in the seeker initialization module, S1I. When the Monte Carlo variables have been identified, the following DO LOOP is established with the C-index of the Monte Carlo variable used to flag MCARLO:

```
C MONTE CARLO STEADY STATE WIND COMPONENT
      DO 500 I = 1, I3512
      IDO = 1
      IF(ISNDX(I).EQ.51) CALL MCARLO (DUM, 1, IDO)
      IF(ISNDX(I).EQ.52) CALL MCARLO (DUM, 1, IDO)
  500 CONTINUE
```

The DO LOOP variables are defined as:

13512 - total number of initial condition error source type 8 cards that are read in OINPT1.

ISNDX(I) - The Monte Carlo variable C-index that appears in the Ith type 8 card.

This DO LOOP checks all the initial condition error sources type 8 cards to determine if any of the type 8 cards contained the C-index number in the IF statement. If an 8-card does contain a C-index (ISNDX) equal to the number, then MCARLO is called to randomly select a value for the variable that has that C-index. The argument list of MCARLO contains a dummy variable DUM, the type of MODE (1 for initial conditions), and the type 8 card number (IDO) that contains the statistical information for the error source.

b. Time Series Error Sources

Time series error modeling will appear in both an initialization module and in a flight simulation module. The initialization module performs all initialization required for that model (MCARLO MODE = 4) and the flight simulation module calls MCARLO to generate the time series random number sequence for the model (MCARLO MODE = 2).

The DO LOOP example that follows was developed for the wind gust model. Initialization is performed in module G2I, while the time series random number generation is performed in the wind module G2.

1) Time series initialization - G2I -

```
C MONTE CARLO  INITIAL VALUE OF TIME SERIES WIND GUSTS
      DO 501 I = 1,ITCT
      IDO = I
      IF(ITNDX(I).NE.70) GO TO 501
      CALL MCARLO ( DUM,4,IDO)
      WNDWO = 1.
      IF(VWTE.EQ.0.) GO TO 505
      SIGU = VWTE/2.9
      GO TO 506
  505 CONTINUE
      VWTE = 2.9 * SIGU
  506 CONTINUE
      GSIGU = SIGU*SQRT(1.89/C(2664))
      BLU = -12.1*SIGU + 475.
      IF(VWTEM/VWTE.GT..1) WNDWO = VWTE/VWTEM
      IPL(N) = 59
      N = N + 1
  501 CONTINUE
```

2) Time series random number generation - G2 -

```
      ICK = 0
      DO 500 IOL = 1,ITCT
      ITSNDX = IOL
C
C  MONTE CARLO WIND GUSTS TIME SERIES
      IF(ITNDX(IOL).NE.70) GO TO 502
      UBAR = 0.
      IF(VWTE.NE.0.) UBAR = ABS((VXE*VHXE + VYE*VHYE + VZE*VHZE)/VHTE)
      CALL MCARLO(DUM, 2, ITSNDX)
      WNDW02 = UBAR/BLU + WNDWJ
      GLW = GSIGU*SQRT(WNDW02)
      SLWD = RLW - WNDW02*SLW
      GVWTE = VWTE + GLW*SLW
      ICK = 1
  502 CONTINUE
  500 CONTINUE
```

The DO LOOP variables are defined as:

ITCT - total number of time series error source type 8 cards read in OINPT1.

ITNDX(I) - the Monte Carlo variable C-index that appears on the Ith type 8 card.

These two DO LOOPS check all the time series error source type 8 cards to determine if any of the type 8 cards contained the C-index number in the IF statement. If an 8-card does contain a C-index (INTDX) equal to the number, then all the calculations and MCARLO calls relating to that model are performed. The argument list of MCARLO in the initialization modules contains a dummy variable DUM, the type of MODE (4 for initialization), and the type 8 card number (IDO) that identifies the Monte Carlo time series variable. The argument list of MCARLO in the flight simulation module contains a dummy variable, DUM, the type of MODE (2), and the type 8 card number (ITSNDX) that identifies the Monte Carlo time series variable.

Other information and calculations are also contained within the DO LOOPS. The specific information and calculations that appear depends upon the model. The time series model given here is a correlated normally distributed model that involves filtered white noise. This involves setting up several auxiliary calculations for the integration of the differential equation inside the MCARLO MODE 2 DO LOOP.

c. Input/Output Variables and Cross Reference of C-Array

Tables 56, 57, and 58 present the input/output variables and cross reference of C-array for MCARLO.

TABLE 56. INPUT FROM DATA CARD - MCARLO

Fortran Symbol	Symbol Used in Text	C Index	Definition
RNSTRT	R_N	3511	Random number generator starting value (seed) - must be an odd octal whole number
IDIST		3674	Type of distribution of initial condition erro source
SIGMA	σ	3514	Initial condition error source standard deviation
SIGLB	σX_L	3554	Initial condition error source lower bound
SGGUB	σX_U	3594	Initial condition error source upper bound
ITDIST		3763	Type of distribution of time series error source
TSPER		3773	Time series sample period of periodic sample rate or mean of sample period if random sample rate
TSGMA	σ	3723	Time series error source standard deviation
TLB	σX_L	3733	Time series error source lower bound
TUB	σX_U	3743	Time series error source upper bound

NOTE: All of these inputs, with the exception of RNSTRT, are read in on 8-cards. Each variable has a unique field assigned to on the 8-card. See Section IV. A. 8 for definition of these fields. RNSTRT is read in on a 3-card.

TABLE 57. INPUT FROM OTHER SUBROUTINES - MCARLO

Fortran Symbol	Symbol Used in Text	C Index	Definition
ISNDX	ISNDX	3634	Array of Monte Carlo. Variable C-indices appearing on 8-cards (initial condition error sources)
ISGCT	13512	3512	Total number of initial condition error sources for this run
ITNDX	ITNDX	3753	Array of time series Monte Carlo error sources C-indices appearing on 8-cards
ITCT	ITCT	3721	Total number of time series error sources for this run
TYPPEP		3783	Flag for time series values, = 0 stochastic = 1 deterministic
TPSIG	σ	3793	Array of time series error source standard deviation
TNXST	TNSST	3803	Time series sampling time; reset each run
ITNDX2		3813	C-indices of time series error sources

TABLE 58. OUTPUT - MCARLO

Fortran Symbol	Symbol Used in Text	C Index	Definition
TMU	u	2805	Calculated mean value of the time series output
TVM		2815	Variance of the time series output
TSIG	σ	2825	Standard deviation of the time series output
TRMS	RMS	2795	RMS of the time series output
YMC		1564	Current Y mean value
YMC2		1565	Current Y mean squared
ZMC		1574	Current Z mean value
ZMC2		1575	Current Z mean squared

D. CIRCULAR ERROR PROBABILITY ANALYSIS SYSTEM

1. Functional Description

CEPAS consists of a distinct set of subroutines that interfaces the 6 DOF program through a control subroutine named CEPAS. Subroutine CEPAS accepts miss distance coordinates from the 6 DOF program after the completion of a run set and automatically generates CEP related information. Through the use of a control parameter input card, user control can be exercised over both the assumptions of the analysis and the output information. This control parameter card is read in by the 6 DOF input subroutine OINPT1 following all 6 DOD/Monte Carlo input data. Detailed input information concerning this control parameter card is given in the input description section of this report, Section III. D. 8.

2. Related Subroutines

The set of subroutines in the stochastic 6 DOF simulation program that are unique to CEP calculations are:

a) CEPAS - CEP analysis system control subroutine.

b) CEPP - CEP calculation subroutine.

c) KSTEST - Kolmogorov-Smirnov (K-S) test subroutine.

d) ZTABLE - Table of areas of the normal probability curve.

e) PPLOT - Printer plot subroutine.

f) XLOC - Auxiliary routine for locating X coordinate for use in PPLOT.

g) NORM - Calculates normalized random value.

h) RANNUM - Uniformly distributed random number generator.

i) NORMAL - Normal (Gaussian) distributed random number.

A list of the variables appearing as arguments to these subroutines is contained in Section III.

3. Assumptions

The CEP calculations made by CEPAS are obtained by either parametric statistical methods, assuming an elliptical bivariate normal distribution, or by nonparametric methods, where no specific distribution is assumed. Because more information can generally be obtained (e.g., confidence circles) from a given size sample when the distribution is known, it is advantageous to use the parametric methods when they apply. For this reason, CEPAS automatically subjects the input miss distance data to a normality test (a K-S test is used [6,7]) to determine whether to use the parametric or nonparametric methods. If the hypothesis of normally distributed data is not rejected by the K-S

test, the parametric method is used; otherwise, the nonparametric method is used. A user option is available which causes the parametric calculations to be used ragardless of the outcome of the K-S test. If this option is utilized, however, and the actual underlying population of miss distance coordinates is significantly non-normal, the resulting CEP information will be unreliable.

The a priori selection of an elliptical bivariate normal distribution is justified in part by the fact that the assumption has yielded satisfactory results for a large number of past systems [4]. If subsequent data obtained from Monte Carlo simulation runs shows that the assumption of a bivariate normal distribution is not justified, the use of other distributions can be considered.

Given that the missile impact points are elliptical bivariate normally distributed, the miss distance statistics could meaningfully be summarized using at least two obvious approaches. One approach would be to calculate an estimate of the parameters of an ellipse containing a given fractional part of the population of impact points. The fractional part would then be interpreted as the probability of a future shot having an impact point within the ellipse. Since the ellipse parameters would be estimates of the true population parameters, based upon the sample points, a confidence ellipse with a specified probability of containing the population ellipse could be defined. An alternative approach would be to convert the elliptical parameters to equivalent CEP parameters. The latter approach was actually taken in CEPAS for two primary reasons: (a) ellipses generated with different system components (e.g., seekers, autopilots, etc.) are difficult to compare when attempting to determine the component exhibiting the most satis-factory performance, and (b) CEP has traditionally been used for representing planar miss distance statistics, with the consequence that the results are more readily recognized by missile system engineers. The conversion from elliptical parameters to equivalent CEP parameters is accomplished utilizing a transformation developed by Stanford Research Institute [8]. It should be noted that even when the underlying population of miss distance coordinates is actually distributed as assumed, at least two factors will prevent any given CEP circle from containing 50% of the sample impact point. The first factor is that even if the CEP of the missile system was known exactly, data sampling fluctuations would generally prevent precisely 50% of the impact points from being within the given CEP circle. The second factor is that the population parameters are, in fact, not known, but must be estimated based upon the sample data itself.

Regardless of whether the CEP calculations are parametrically or nonparametrically based, the CEP circle center is taken to be the centroid of the sample miss distance coordinates.

The calculation of the CEP and confidence circle radii, for the parametric case, is discussed in Section III. D. 7. No confidence circle is calculated in the nonparametric case. The CEP radius in the nonparametric case is assumed to be such that as many points lie inside the circle as outside. The only occasions where this cannot be done are the very infrequently occurring ones where more than one impact point lies exactly on the CEP circle circumference, and the number of remaining points is odd. In this case, the number of points inside and outside the circle will differ by one.

4. 6 DOF Simulation System Compensation

When CEP calculations are parametrically based, additional CEP information can be optionally obtained from CEPAS, using the supposition that the 6 DOF program does not precisely represent the actual missile system. The deviation of the 6 DOF program from the actual system performance in terms of miss distance coordinates would only be approached by comparing results of a large number of test firings with simulations of such test firings. Since such an approach is economically impractical, the simplifying assumption has been made that the 6 DOF simulator represents an impact point measuring system having a CEP equal to $\lambda(\lambda \geq 0)$ times the CEP of the missile system, where λ is an input parameter. This assumption appears justified in part by the fact that if a firing was made, and an analoguous (same conditions simulated 6 DOF) simulation run made, then the actual and the simulated impact points could be expected to differ by some amount. Further, if a large number of such comparisons were made, some distribution of the differences would be expected (ignoring bias errors). In this sense, the 6 DOF simulator can be considered a measuring system of the actual missile system impact points. The mathematical formulas utilized in CEPAS were derived under the assumption that a measuring system utilized to record the position of actual impact points would yield different position data each time the same impact point is measured. (This fact is due to the inherent imprecisions in the measuring system.) While it is recognized that this is not strictly the sense upon which the formulas are being utilized in CEPAS (with $\lambda > 0$), it is felt that a close analogy exists between the 6 DOF simulation program and a measuring system.

In normal operation, CEPAS defaults to $\lambda = 0$, and the resulting CEP information can be interpreted as a prediction of the missile system CEP, based on the assumption that the impact points predicted by the 6 DOF program exhibit no dispersion about actual impact points.

When λ is input greater than zero, two sets of CEP information are calculated by CEPAS. The $\lambda = 0$ case is calculated for reference, and a second set of CEP information is calculated under the assumption that the 6 DOF program exhibits a CEP about a single actual impact point of λ times the CEP of the missile system. The equations used in the CEP calculations for $\lambda > 0$ are discussed in Section III. D. 7.

5. Confidence Circles

The CEP parameters (centroid and radius) of the miss distance population are estimated in CEPAS using sample data, and are consequently subject to the usual estimation errors. In order to bound these errors with a specified probability, a user option permits inputting any combination of five confidence levels (99%, 95%, 90%, 80%, and 70%). The selection of a given confidence level will result in CEPAS computing a circle of radius R within which the actual missile system CEP is assumed to be located. The validity of this calculation depends upon the fidelity of the 6 DOF simulation program and the data points being bivariate normally distributed. For each confidence level selected, CEPAS will calculate and display the confidence circle. Confidence circles are not calculated if the CEP is calculated nonparametrically (Section III. D. 3.), i.e., if the data are not bivariate normally distributed.

6. Printer Plots

Printer plots of the CEP circle, the confidence circle (if generated), and the input miss distance points can be generated as a user option. If the user has input a value of λ greater than zero (Section III. D. 4.), then two plots will be generated for each confidence level entered by the user; one plot will display the CEP and confidence circles for $\lambda = 0$, and the other will display the same information for the input values of λ.

Samples of the printer plots are included in Section IV. B. 3.

7. Equations

The equations used for calculating CEP and confidence circles are included below.

The Chi-square, normal, and critical K-S tables required for computations are loaded in various programs arrays.

a. <u>Sample Estimate of Standard Deviations in Y and Z.</u>

$$\text{Azimuth:} \quad S_Y^2 = \frac{1}{N-1}\left[\sum_{i=1}^{N} Y_i^2 - \frac{1}{N}\left(\sum_{i=1}^{N} Y_i\right)^2\right]$$

$$\text{Deviation:} \quad S_Z^2 = \frac{1}{N-1}\left[\sum_{i=1}^{N} Z_i^2 - \frac{1}{N}\left(\sum_{i=1}^{N} Z_i\right)^2\right]$$

where (Y_i, Z_i) denotes ith set of input miss distance coordinates and N denotes number input coordinate pairs.

b. <u>CEP and Confidence Circle Centroid</u>

Sample estimate of CEP and confidence circle centroid is $(\bar{Y},\bar{Z})$, where

$$\bar{Y} = \frac{1}{N} \sum_{i=1}^{N} Y_i$$

$$\bar{Z} = \frac{1}{N} \sum_{i=1}^{N} Z_i \quad .$$

c. <u>Determination of CEP and Confidence Circle for $\lambda = 0$</u>

The calculation of the missile system CEP and confidence circle radii for $\lambda = 0$ (i.e., assuming no measuring system CEP) is performed as follows:

$$\text{Let } S^2_{MIN} = \text{Minimum } [S^2_Y, S^2_Z]$$

$$S^2_{MAX} = \text{Maximum } [S^2_Y, S^2_Z] \quad ,$$

then for

$$\frac{S_{MIN}}{S_{MAX}} \geq 0.3, \; CEP_J = 0.615 S_{MIN} + 0.562 \, S_{MAX}$$

and

$$\frac{S_{MIN}}{S_{MAX}} < 0.3, \; CEP_J = 0.9988 \left(\frac{S^2_{MIN}}{S_{MAX}}\right) - (0.0496) S_{MIN} \quad ,$$

$$+ (0.675) S_{MAX}$$

where CEP_J represents the CEP radius calculated on the assumption that $\lambda = 0$, (6 DOF program inpact points exhibits no dispersion about actual impact points). The confidence circle radius, R_J, is calculated from

$$R_J = \sqrt{\frac{2(N-1)}{X^2_{\upsilon,P}}} \; CEP_J \quad ,$$

where N is the number of data points, υ is the degrees of freedom (υ = 2(N-1) in this case], and P is one of the confidence levels requested by the user. Chi-square (X^2) values are tabulated by degrees of freedom and confidence level.

d. Determination of CEP and Confidence Circle for $\lambda > 0$

If $\lambda > 0$ then the following formulas are utilized by CEPAS:

$$CEP_S = \frac{CEP_J}{\sqrt{1 + \lambda^2}}$$

$$R_S = \frac{R_J}{\sqrt{1 + \lambda^2 - \frac{\lambda^2 X^2_{\upsilon,P}}{2(N-1)}}}$$

where CEP_S and R_S are the CEP and confidence circle radii with the effect due to the assumed dispersion of the measuring system removed.

8. Input Description and Variables

The input format for CEPAS control parameter data card is given in Section IV. A. 9.

(Note): The CEP calculations made by CEPAS are obtained by either parametric statistical methods, assuming an elliptical bivariate normal distribution, or by nonparametric methods, where no specific didtribution is assumed. Because more information congenerally be obtained (e.g., confidence circles) from a given size sample when the distribution is known, it is advantageous to use the parametric methods when they apply. For this reason, CEPAS automatically subjects the input miss distance data to a normality test (a K-S test is used) to determine whether to use the parametric or nonparametric methods. If the hypothesis of normally distributed data is not rejected by the K-S test, the parametric method is used; otherwise, the nonparametric method is used. A user option is available which causes the parametric calculations to be used ragardless of the outcome of the K-S test. If this option is utilized, however, and the actual underlying population of miss distance coordinates is significantly non-normal, the resulting CEP information will be unreliable.)

Table 59 contains a list of variables as they appear in the argument lists of the various CEPAS subtoutines.

E. Executive Subroutines

1. Module Initialization Executive Subroutine (AUXI)

The module initialization subroutines are called by subroutine AUXI according to the input module data control cards (type 2 input data cards - see Section IV for input card formats).* AUXI is called by the MAIN program after the input subroutine, OINPT1, is called, and prior to entering the integration loop. AUXI contains calls to a number of initialization subroutines which exist only as nonfunctional entry points in the subroutine DUMMY. Thus, for example, AUXI calls A2I, which by the naming convention would correspond to the initialization subroutine for the forces and moments module, A2. However, no subroutine A2I exists, which results in the compiler accessing the entry point A2I in DUMMY, which simply returns control back to AUXI.

Table 60 shows the functional module initialization subroutines, along with the module number which initiates the subroutine call in AUXI.

2. Module Executive Subroutine (AUXSUB)

Subroutine AIXSUB is an executive routine which calls the modules input on type 2 data cards in the order of input (see Section IV for input data card format). AUXSUB is called by the MAIN program. It is in the integration loop, and consequently, is called by MAIN at every integration step. AUXSUB contains calls to modules that exist only as nonfunctional entry points in subroutine DUMMY.

Table 61 lists the existing modules and their associated module numbers which, when input on type 2 data cards, cause AUXSUB to call the modules in input order.

3. SUBL1 - Executive Subroutines

This executive subroutine is functionally inactive. It is called by MAIN, and in turn calls INPT1, OUPT1, STGE1, CNTR1, RNDM1, AUXA1, AUXB1, and AUXC1, depending upon the subroutine numbers stored in the array, SUBNO (I). However, all of the subrountine names called (INPT1, OUTP1, etc.) exist only as entry points in subroutine DUMMY.

---

*AUXI will automatically call an initialization subroutine for each module specified on a type 2 input card; i.e., no input cards are required for initialization subroutines.

TABLE 59. CEPAS SUBROUTINE ARGUMENT VARIABLES

Fortran Symbol	Symbol Used in Text	C Index	Definition
NP		CEPAS, CEPP KSTEST, PPLOT	Number of points
IBVNSW		CEPAS, CEPP	= 1, if desire to use bivariate normal assumption regardless of outcome of K-S test ≠ 1, if to use bivariate normal only if K-S test does not reject assumption of normality If ≠1 and data fails K-S test for normality, CEP will be calculated as the radius, R, of a circle containing 1/2 of the sample points
IPLOT		CEPAS CEPP	= 1, for plots of CEP(s) and points, otherwise, ≠ 1.
XLAMBD		CEPAS CEPP PPLOT	(Program CEP)/(Missile CEP), = 0, if no estimate of program CEP is made
KSSIG		CEPAS CEPP KSTEST	Significance level for K-S test desired, negative if not K-S test desired
CEPSIG		CEPAS CEPP	Confidence level (CEPSIG(1) = 90, CEPSIG(2) = 99, CEPSIG(3) = 70, etc.)
PSIZE		CEPAS CEPP PPLOT	Plot size of Y-axis (for scaling), if = 0, PPLOT scales itself
X		CEPP PPLOT	Array of X-component of miss distances
Y		CEPP PPLOT	Array of Y-component of miss distances
RX		NORM	Monte Carlo value of normally distributed error source

TABLE 59. (Continued)

Fortran Symbol	Symbol Used in Text	C Index	Definition
XL		NORM	Lower bound of time series, error source
XU		NORM	Upper bound of time series, error source
XMU		NORM	Mean of time series error source
SGMA		NORM	Standard deviation of time series error source
RNSTRT		NORM	Random number generator starting value
XBAR		KSTEST	Not used in KSTEST
		PPLOT	X-coordinate of CEP centroid
SXHAT		KSTEST	Not used
NI		KSTEST	K-S test failure flag, = 1 fails.
Z		ZTABLE	Standardized random variable
FREQ		ZTABLE	Accumulative probability
NZT		ZTABLE	Not used
CEP		PPLOT	CEP
ICHI		PPLOT	Input confidence level
RCONF		PPLOT	Radius of the ICHI referenced confidence circle
TITLE		PPLOT	Alphanumeric titles for output purposes
YBAR		PPLOT	Y-coordinate of CEP centroid
XVAL		XLOC	Input value of X-coordinate
HSPRD		XLOX	X-axis scale factor
IWD INDX		XLOC	Indexes used in determining X-coordinate location

4. SUBL2 - Executive Subroutine

a. Functional Dexcription

Executive subroutine, SUBL2, is called by MAIN immediately after the module initialization subroutine, AUXI, is called SUBL2, in turn, calls INPT2, OUPT2, STGE2, CNTR2, RNDM2, AUXA2, AUXB2, and AUXC2, depending upon the subroutine numbers stored in the array, SUBNO(I)*. The array, SUBNO(I), is initialized in OINPT1, by the subroutine numbers entered on type 1 input data cards, with the current

configuration of the simulation program, two type 1 cards are input to enter subroutine numbers 3 and 4 into the SUBNO(I) array. This will cause subroutines OUPT2 and STGE3 (described in Sections III. G. 2 and 3. F. 11 *, respectively) to be called by SUBL2.

Table 60. Module Initialization Subroutine Numbers

Name	Function	Subroutine Number
A1I*	AERO coefficient module initialization	2
A3I	Engine module initialization	4
SPOTI	Spot jitter module initialization	38
C1I	Autopilot module initialization	7
C4I	Actuator initialization	10
D1I	Translational dynamics module initialization	17
D2I	Rotational dynamics module initialization	18
S1I	Seeker module initialization	28

*A1I is an entry point in C4I.

TABLE 61. MODULES AND ASSOCIATED MODULE NUMBERS

Module Name	Function	Module Number
A1	AERO coefficient table look-up	2
A2	Forces and moments module	3
A3	Engine module	4
C1	Autopilot module	7
C4	Actuator module	10
D1	Translational dynamics module	17
D2	Rotational dynamics module	18
G2	Winds module	23
G3	Air data module	24
SPOT	Spot jitter module	38
G5	Coordinate transformation module	26
S1	Seeker module	28

5. <u>SUBL3 - Executive Subroutine</u>

Executive subroutine, SUBL3, is called by MAIN at every integration step. SUBL3, in turn, calls INPT3, OUPT3, STGE3, CNTR3, RNDM3, AUXA3, AUXB3, and AUXC3 depending upon the subroutine numbers stored in the array, SUBNO(I).* The array, SUBNO(I), is initialized in OINPT1 by the subtoutine numbers entered on type 1 input data cards. With the current configuration of the simulation program, two type 1 cards are input to enter subroutine numbers 3 and 4 into the SUBNO(I) array. This will cause SUBL3 to call subrottines OUPT3 and STGE3 (described in Sections III. G. 2 and III. F. 12).* Table 62 presents the SUBL3 input/output variables.

TABLE 62. SUBL3 INPUT/OUTPUT VARIABLES

Fortran Symbol	C Index	Definition
NOSUB	2461	Number of subroutines specified on type 1 input data cards
SUBNO(I)	2462	Subroutine numbers entered on type 1 input data cards

6. Table Look-Up Subroutines: TABLE, TABL2, and TABL3

These three subroutines are used for the express purpose of passing tabular aerodynamic data to the special function subroutines FINTP1, FINTP2, and FINTP3. These special function subroutines performs linear interpolation between two points in three types of tabular data tables. These data tables are:

a) TABLE FINTP1 - one dependent, one independent variable.

b) TABL2 FINTP2 - one dependent, two independent variables.

c) TABL3 FINTP3 - one dependent, three independent variables.

The independent variable tables must be monotonically increasing data arrays. The argument list variables of the three subroutines are:

a) TABLE (X, XI, YI, NX, YK, XLABEL, Y) -

X - Instantaneous value of independent variable.

XI - Independent variable array (table).

YI - Dependent variable array (table).

---

*All of the named subroutines except INPT3 and OUPT3 exist only as entry points in the subroutine DUMMY.

NX - Number of points in each table.

XK - Flag used in FINTP1.

XLABEL - reserved for holorith character name of data table.

Y - Innear interpolated value of the dependent variable.

b) TABLE (X, Y, XY1, ZI, NXY, XINTER, XLABEL, Z) -

X - Instantaneous value of the first independent variable XI.

Y - Instantaneous value of the second independent variable YI.

XYI - This single array contains both the first (XI) and second (YI) independent variable tabular values. The first independent variable (XI) values occupies the leading element locations and the second independent variable (UI) values occupies the remaining element locations.

ZI - Dependent variable array. This array contains all dependent variable tabular values. The dependent variable values as a function of the first independent variable XI are subgroups of data in the array. The subgroups are then a function of the second independent variable YI. (The subgroups must be ordered such that they are a function of YI with YI monotonically increasing.)

NXY(I) - Number of points in the data tables:

I = 1, number of first independent variablle (XI) data points

I = 2, number of second independent variable (YI) data points.

XINTER - Flag used in FINTP2.

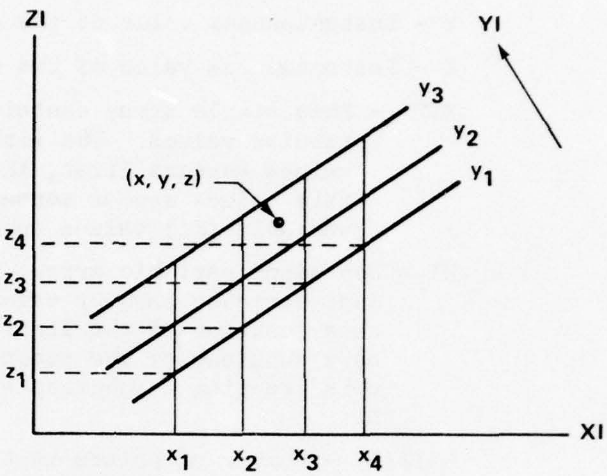
XLABEL - Reserved for holorith character name of data table.

Z - linear interpolated value of the dependent variable.

The following is an example of TABL2 use.

Assume the following set of data:

ZI	XI	YI
z_1	x_1	y_1
z_2	x_2	
z_3	x_3	
z_4	x_4	
z_5	x_1	y_2
z_6	x_2	
z_7	x_3	
z_8	x_4	
z_9	x_1	y_3
z_{10}	x_2	
z_{11}	x_3	
z_{12}	x_4	



These tabular values would be assigned to the argument list arrays as follows:

$$XYI = x_1, x_2, x_3, x_4, y_1, y_2, y_3$$

$$Z_I = \left| \overbrace{z_1, z_2, z_3, z_4}^{y_1} \middle| \overbrace{z_5, z_6, z_7, z_8}^{y_2} \middle| \overbrace{z_9, z_{10}, z_{11}, z_{12}}^{y_3} \right| .$$

The number-of-points variables would be set as:

$$NXY(1) = 4$$
$$NXY(2) = 3 .$$

The discrete point (x, y) would be passed into the subroutine, a linear interpolation would be performed between the data points that bracketed (x, y) and a singular value of z would be returned. Thus,

$$\left.\begin{array}{l} X = x \\ Y = y \end{array}\right\} \text{input}$$
$$Z = z \text{ - returned value.}$$

c) TABL3 (X, Y, Z, XYZI, WI, NXYZ, XINTER, XLABEL, W) -

X - Instantaneous value of the first independent variable XI.

Y - Instantaneous value of the second independent variable YI.

Z - Instantaneous value of the third independent variable ZI.

XYZI - This single array contains all three independent variable tabular values. The first independent variable (XI) values appears first, the second independent variable (YI) values appear second, and the third independent variable (ZI) values appear last.

WI - Dependent variable array. This array contains all dependent variable tabular values. The dependent variable values as a function of the first independent variable (XK) appears as a subgroup of the second independent variable YI with this grouping a subgroup of the third independent variable ZI.

NXYZ(I) - Number of points in the data tables:

I = 1, number of first independent variable (XI) data points

I = 2, number of second independent variable (YI) data points

I = 3, number of third independent variable (ZI) data points.

XINTER - Flag used in FINTP2.

XLABEL - Reserved for holorith character name of data table.

W - Linear interpolated value of the dependent variable.

F. Auxiliary and Function Subroutines

1. Aerodynamic Coefficient Table Error Indication Subroutines: AERROR and TERROR

Subroutine AERROR is used to indicate that the numerical range of an aerodynamic coefficient data table has been exceeded by the trajectory being flown. The message "OUT OF AERO TABLE ARGUMENT ARRAY" and the table name is printed out, along with a dump of the C-array element string that contains all the aerodynamic table values. The integration termination switch, LCONV, is then set to 2 to flag subroutine STGE3 that the run is to be terminated.

Subroutine TERROR is used to indicate that an entire aerodynamic coefficient table is missing. The message "NO AERO POINTS SPECIFIED FOR ARG" and the missing table name is written out. The run is then terminated by a CALL EXIT statement.

NOTE: These two subroutines are not being utilized by the program. No provision has been made to detect these errors in the aero tables not to call these subroutines.)

2. AMRK - Numerical Integration Routine

a. Functional Description

Numerical integration of the state vector derivatives is accomplished using the standard four pass fixed step Runge-Kutta technique. This routine numerically solves a simultaneous system of N first order differential equations.

AMRK calls AUXSUB, which inturn calls each functional module to evaluate state vector derivatives, update the state vectors, and calculate scalar quantities needed for evaluation of the derivatives.

b. Equations

The following equations show the calculations performed by AMRK. All state vector derivatives are evaluated on each pass of the four passes. Specifically, if the state vector derivative, $\dot{Y}_i$, is a function of time, n state vectors, and m scalar quantities,

$$\dot{\bar{Y}}_i = f(t, Y_{j=1,n}, X_{k=1,m}) \quad .$$

Then Y_i at $(t_0 + t)$ is evaluated by

$$\bar{Y}_i = \bar{Y}_{i_0} + 1/6(K_{1_i} + 2K_{2_i} + 2K_{3_i} + K_{4_i}) \quad ,$$

where

$$K_{1_i} = f(t_0, \bar{Y}_{j=1,n}, X_{k=1,m})\Delta t$$

$$K_{2_i} = f\left[\left(t_0 + \frac{t}{2}\right), \left(\bar{Y}_{j_0} + \frac{K_{1_j}}{2}\right)_{j=1,n}, \left(X_k\right)_{k=1,m}\right]\Delta t$$

$$K_{3_i} = f\left[\left(t_0 + \frac{t}{2}\right), \left(Y_{j_0} + \frac{K_{2_j}}{2}\right)_{j=1,n}, \left(X_k\right)_{k=1,m}\right]\Delta t$$

$$K_{4_i} = f\left[(t_0 + t), (Y_{j_0} + K_{3_j})_{j=1,n} \quad (X_k)_{k-1,m}\right]\Delta t \quad ,$$

and

t_0 = Time at start of integration step

$\bar{Y}_{i0}$ = Value of ith state vector being evaluated at start of integration step

$\bar{Y}_{j0}$ = Value of all n state vectors at start of integration step

t = Integration step size.

Sometimes it is necessary to avoid calculation of source scalar quantities on all but the first pass of the four passes. Therfore, a flag, XNDRK, is set to specify the first pass. Accordingly,

First pass - XNDRK = + 1.

All other passes - XNDRK = - 1.

c. Initialization

AMRK integration variables (state vector derivatives) are assigned in the initialization routine of each functional module. All state vector derivatives and integrated values are stored in the C-array. The IPL-array stores the pointers that point to the C-location or index of the derivative. The integrated value is automatically moved to 3 C-locations above the index of the derivative. For instance, if a second order derivative, Y, is to be assigned to C-location 300, then Y will be located in 303. Then the appropriate initialization routine

IPL (N) = 300
N = N + 1.

This will result in

$$C\ (300) = \ddot{\bar{Y}}$$
$$C\ (303) = \dot{\bar{Y}} \quad .$$

N is the counter specifying the number of differential equations to be evaluated. N must be increased by the number of differential equations added to the IPL-array in each initialization routine.

If it is desired to continue the integration of this variable, $\dot{\bar{Y}}$, to bet $\bar{Y}$, then

IPL (N) = 300
IPL (N + 1) = 303
N = N + 2.

This will result in

$C\ (300 = \ddot{\bar{Y}}$

$C\ (303) = \dot{\bar{Y}}$

$C\ (306) = \bar{Y}$.

d. Assumptions and Limitations

There are two important restrictions placed on the integration scheme.

(1) Rail Launched Missiles. If the missile is rail launched, then the integration stepsize is fixed in the program at 0.002 sec (in seeker initialization routine). This was done so that all runs with the same initial conditions would have the same rail drop-off time, regardless of the input value of integration stepsize. This was deemed necessary because rail drop off is checked only at the end of an integration pass. Thus, if integration stepsize is varied effectively, rail length and rail drop off time would vary, resulting in slightly direct flight paths for identical initial conditions.

Following rail dropoff, the integration stepsize is switched from 0.002 sec to the input value. Switching is normally accomplished in the seeker module, since integration must be synced with the seeker sample period (see following).

(2) Integration Synchronization with Sample Period. Numerical integration must be synchronized with sample period [2] in order to insure accurate integration. Logic is built into the seeker subroutines to insure that integration and sample period are synchronized. This is accompliehd by:

$$\Delta t = \tau / [\mathrm{AINT}(\tau / \Delta t_{INPUT})] \quad ,$$

where

τ = Sample period (sec)

Δt_{INPUT} = Input integration stepsize (sec)

AINT(X) = Computer function that integerizes the argument (X)

Δt = Computer integration stepsize that the program will use.

The above function will always compute an integration stepsize that is equal to or greater than the input stepsize. Since there is an upper bound on the stepsize that can be used to integrate the differential equations in this simulation program, there is the possibliity that a stepsize larger than the upper bound will be computed. (Upper bound is approximately 12.5 msec, with the exception of the OCS seeker model

S2 which has an upper bound of approximately 0.5 msec). Therefore, one should insure that a reasonable stepsize is input and verify that a reasonable stepsize is computed. For example, if the sample period is 16.7 msec, then a stepsize of 8.35 msec or less must be input to insure that the computed stepsize is 12.5 msec or less.

e. Input/Output and Cross Reference of C-Array

Tables 63, 64, and 65 present the input/output and cross reference of C-array for AMRK.

TABLE 63. INPUT FROM DATA CARDS - AMRK

Fortran Symbol	Symbol Used in Text	C Index	Definition
DELT	Δt	2664	Integration stepsize (sec)

TABLE 64. INPUT FROM OTHER MODULES - AMRK

Fortran Symbol	Symbol Used in Text	C Index	Definition
T	t	2000	Flight time (sec)
N	NJ	2661	Number of differential equations
IPL	IPL	2562	Integration pointer array
C(J)	Y_j	IPL	State vector derivatives
C(J + 3)	Y_j	IPL + 3	Integrated value of state vector

TABLE 65. OUTPUTS - AMRK

Fortran Symbol	Symbol Used in Text	C Index	Definition
C(J + 3)	Y_j	IPL + 3	Integrated value of state vector
XNDRK	XNDRK	1976	Runge - Kutta pass flag +1. first pass -1. second, third, and fourth pass

3. Trig Special Function Routines: COSD, SIND, and ATAND

The special function trig routines COSD, SIND, and ATAND allow the user to work in units of degrees when dealing with angles. Use of the Fortran supplied functions COS, SIN, and ATAN2 is made through these intermediate special function routines. The input to the special functions COSD and SIND is Z, an angle expressed in degree, while the outputs are returned in X and Y, respectively.

$$Y = COSD(Z)$$
$$Y = SIND(Z) \quad .$$

Output of the special function ATAND is

$$Z = ATAND(Y,X) \quad ,$$

where Z is an angle in degrees with assignment to the proper quadrant and a range of $\pm$ 180 degrees.

4. DUMMY - Auxiliary Subroutine

Subroutine DUMMY contains, as ENTRY points, all of the subroutine names called in the simulation program. This feature allows the program to be modularly altered (e.g., removing a module or subroutine or substituting a module or subroutine) without the necessity of locating and removing all calls to nonexistent subroutines. A disadvantage to this approach is that the inadvertent omission of a needed subroutine will be detectable only by erroneous output results, because the subroutine will exist as an entry point in DUMMY, and a call to the subroutine will not cause a premature program termination.

5. DUMPO - Auxiliary Subroutine

Subroutine DUMPO prints the entire C-array when called. With the current program configuration, DUMPO can be called a maximum of seven times; six times by the input variable DOC and one time by the input variable OPTN10.

DOC allows C-array dumping for six integration intervals, starting with t = 0, and continuing for the next five integration steps. The input variable, DOC, is set to the number of C-array dumps fewer than six desired. Thus, if the six dumps are desired, DOC would be set to zero on input. If no dumps were desired, DOC would be set to six, etc. DUMPO is called by subroutine OUPT2 to provide a C-array dump at t = 0 if DOC is input less than six. Subsequent calls (if any) of DUMPO are made from subroutine OUPT3, within the integration loop.

If the input variable, OPTN10, is set greater than zero, the MAIN program will call DUMPO at the end of a case and dump the C-array.

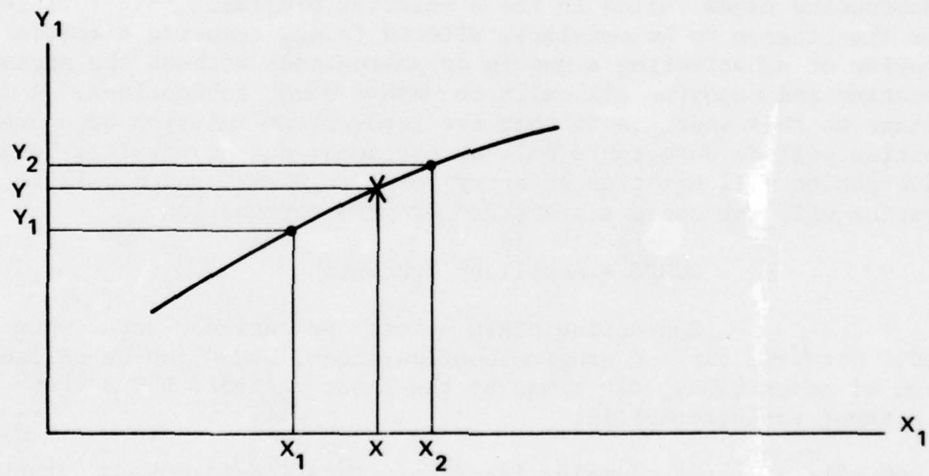
6. FINTP1 - Aero Table Linear Interpolation of a Function with one Dependent and One Independent Variable

Function FINTP1 utilizes the following equation to linearly interpolate between the two points for the value of the dependent variable when the dependent variable is a function of only one independent variable.

$$Y = P_{CT}(Y_2 - Y_1) + Y_1 \quad ,$$

where

$$P_{CT} = \frac{X - X_1}{X_2 - X_1} \quad .$$



The argument list variables, which are internal inputs to the subroutine, are defined as:

X - Instantaneous value of the independent variable XI.

XI - Independent variable array.

YI - Dependent variable array.

N - Number of points in the arrays.

F - Flag that allows bypassing the computation of PCT.

XL - (Not used).

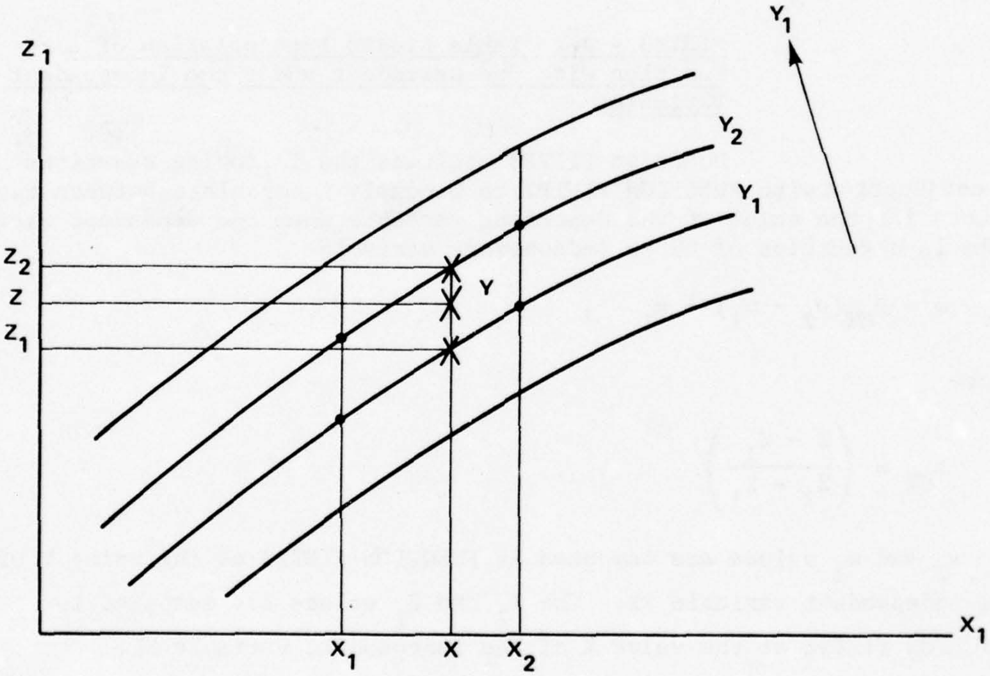
7. <u>FINTP2 - Aero Table Linear Interpolation of a Function With One Dependent and Two Independent Variables</u>

Function FINTP2 utilizes the following equations in conjunction with FUNCTION FINTP1 to linearly interpolate between two points for the value of the dependent variable when the dependent variable is a function of two independent variables:

$$Z = P_{CT} \; (Z_2 - Z_1) + Z_1 \quad ,$$

where

$$P_{CT} = \frac{Y - Y_1}{Y_2 - Y_1} \quad .$$



The Z_1 and Z_2 values are computed in FUNCTION FINTP1 at the value X of the independent variable XI.

The argument list variables, which are internal inputs to the subroutine, are defined as:

X - Instantaneous value of the first independent variable XI.

Y - Instantaneous value of the second independent variable YI.

XI - First independent variable array.

YI - Second independent variable array.

ZI - Dependent variable array.

NXO - Number of points in the first independent variable array.

NY - Number of points in the second independent variable array.

NX - Number of points in the first independent array.

F - Flag that allows bypassing the computation of PCT.

XL - (Not Used).

8. FINTP3 - Aero Table Linear Interpolation of a Function with One Dependent and Three Independent Variables

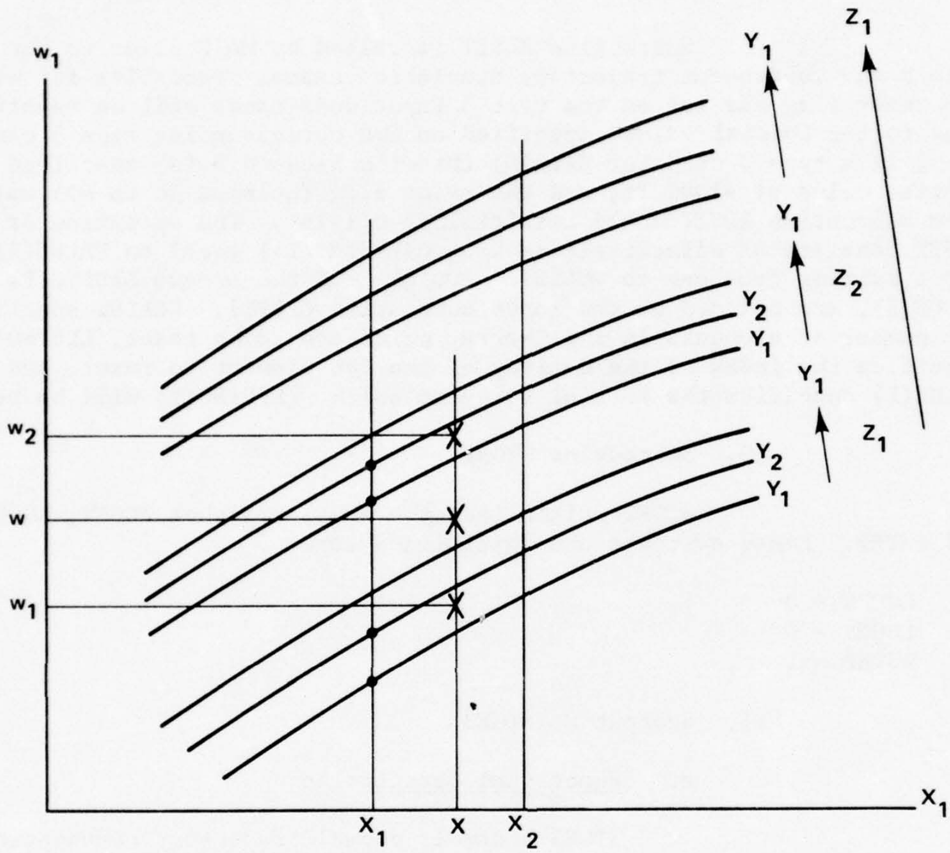
Dunction FINTP3 utilizes the following equations in conjunction with FUNCTION FINTP2 to linearly interpolate between two points for the value of the dependent variable when the dependent variable is a function of three independent variables:

$$w = P_{CT}(w_2 - w_1) + w_1 \quad ,$$

where

$$P_{CT} = \left(\frac{Z - Z_1}{Z_2 - Z_1}\right) \quad .$$

The w_2 and w_1 values are computed in FUNCTION FINTP2 at the value Y of the independent variable YI. The Z_2 and Z_1 values are computed in FUNCTION FINTP1 at the value X of the independent variable XI.



The argument list variables, which are internal inputs to the subroutine, are defined as:

X - Instantaneous value of the first independent variable XI.

Y - Instantaneous value of the second independent variable YI.

XI - First independent variable array.

ZI - Third independent variable array.

WI - Dependent variable array.

NZ - Number of points in the ZI array.

NY - Number of points in the XI array.

F - Flag to bypass computation of PCT in FUNCTION FINTP2.

XL - (Not used).

9. RESET - Multicase Variable Reinitialization

Subroutine RESET is called by MAIN prior to the second and subsequent trajectory simulation cases. Variables for which the reset flag was set on the type 3 input data cards will be reinitialized to the initial values specified on the corresponding type 3 cards. Thus, if a type 3 card for C(1615) (missile X-coordinate) specified an initial value of -1000 ft, and the reset flag (columns 46 to 60) was 1., then subroutine RESET would reinitialize C(1615). The operation of RESET consists of effectively setting C(LISTNO(I)) equal to VALUE(I), for I ranging from one to NOLIST. NOLIST, and the arrays LISTNO(I) and VALUE(I), are defined by the input subroutine OINPT1. NOLIST specifies the number of elements in the C-array which are to be reset, LISTNO(I) specifies the index of the C-array of the Ith element to reset, and VALUE(I) specifies the initial value to which C(LISTNO(I) will be reset.

10. Subroutine STGE2

STGE2 initializes the STGE3 switches KCONV, LCONV, and KSTEP. These switches are initialized as:

KCONV = 0
LCONV - 0
KSTEP = 1 .

11. Subroutine STGE3

a. <u>Functional Description</u>

STGE3 controls normal trajectory computation termination and calls OUPT3 for output following trajectory termination. There are three modes of normal trajectory computation termination handled by STGE3. The events defining these three modes are:

1) Flight time (T) reaches the input maximum flight time boundary (TF).
2) Missile reaches the point of closest approach to the target trajectory intersects the target plane) (flagged in G4).
3) Missile flies into the ground (flagged in G4).

Trajectory computation will be terminated by the event that occurs first. When termination is to occur as a result of one of the previously mentioned events, STGE3 sets the switch KSTEP equal to 2 to flag MAIN that the case is to be terminated.

Mode 1 is handled directly by STGE3. The actual flight time T is compared to the input maximum flight time boundary TF. If T is within 0.01 sec of TF, STGE3 sets the switch KSTEP for case termination. However, if T exceeds TF, STGE3 initiates an integration step size halving

scheme to iterate for a final integration step size to force T to fall within the 0.01-sec tolerance of FT. If, however, T does not fall within this tolerance of TF after ten interval halving passes, the case will be automatically terminated.

Modes 2 and 3 are handled indirectly by STGE3. These events are determined in other modules with the module making the determination setting the switch LCONV equal to 2 to flag STGE3 that an event has occurred and that trajectory computation is to terminate. STGE3 monitors LCONV, and when a value of 2 appears, STGE3 sets the switch KSTEP equal to 2 to flag MAIN that the case is to be terminated.

The definition of variables used in STGE3 is given in Table 66.

b. Initialization Subroutine

Subroutine STGE2 initially sets the flags LCONV = 0 and KSTEP = 1. STGE2 is called by subroutine SUBL2 at the start of trajectory initialization.

12. ZERO - Auxiliary Subroutine

Subroutine ZERO zeros certain elements of the C-array. The variable names and the corresponding C-array indices are:

Variable Name	C-array Index
NPLOT	1984
OPOINT	2023
NOMOD	2361
NOSUB	2461
NOLIST	3066
NOOUT	3167

G. Input/Output Subroutines

1. OINPT1 - Input Subroutine

Subroutine OINPT1 reads the input data cards. The input information is stored in arrays determined by the data card type number (see Section IV for input data card formats). Table 67 lists the input data card types and Table 68 lists the array in which input information is stored. Other than the type 6 card, which must come at the end of a data set, the cards can be input in any order. The module and staging subroutine control cards; however, the order must correspond to the desired execution order of the subroutines and modules.

TABLE 66. DEFINITION OF VARIABLES USED IN STGE3

Fortran Symbol	C Index	Source Module(s) or Input Data	Definition
T	2000	AMRK	Number of seconds into flight simulation (flight time)
TF	2001	INPUT	Upper bound to simulation flight time (flight time cutoff) (sec)
PCNT	2003	OUPT2 OUPT3 STGE3	Time boundary in seconds below which no output/plotting from OUPT3 is performed
STEP	2010	INPUT	Switch that specifies the nature of the next case that follows termination of this case. (STEP=11 indicates that no additional case follows)
KSTEP	2011	STGE2 STGE3	Switch used to flag MAIN that run termination has occurred. (Set to 1 in STGE2; set to 2 in STGE3) 1 - continue integration 2 - stop integration
LCONV	2020	STGE2 G4 S2 S3	Switch used to flag STGE2 that run termination is to occur. 0 - continue integration 1 - ? 2 - terminate computation
DER(1)	2664	INPUT	Integration step size (sec)
KCONV	2021	STGE2 OUPT2 STGE3	Pass counter for step size halving in the iteration loop to force T within the hard wired tolerance of 0.01 sec of TF. (Set to zero in STGE2 and OUPT2)
N NPT NJ	2561 1975 1974	Program Variables	Counter for loading IPL array integration mode control switch number of derivations

TABLE 67. INPUT DATA CARD INFORMATION

Card Type	Data Field 1	2	3	4	5	6	7	8	9	10	11
1	Card Type	Identification	Subroutine No.								
2	Card Type	Identification	Module No.								
3	Card Type	Identification	C-array Index				Index variable value	Reset flag			
4	Card Type	Identification	C-array Index								
6	Cr: l Type	Identification									
7	Card Type	Identification	C-array index	Not used	Scale option	Not used	Fixed scale upper limit	Fixed scale lower limit			
8	Card Type	Identification	C-array index	Type distribution of error source	Type of period for time series sampling	Standard development of sample period of time series parameter see Section IV. A. 6	Error source standard development if normal distribution; an interval multiple if uniform distribution	Error source lower bound	Error source upper bound	C-index of location to store random error value, if blank error stored in field 3	Time series sampling period, if periodic sample rate; or mean of sample period if random sample rate
9	Card Type	A 9-card requires the reading of another data card whose parameters are described in Section IV. A. 7.									
10	Card Type	Identification of variables for which mean variable and standard development is computed	C-array index								

TABLE 68. FORTRAN ARRAY NAMES

Data Card Type	Stored in Array										
	1	2	3	4	5	6	7	8	9	10	11
1			SUBNO								
2			MODNO								
3			L				C (L)	LISTNO			
4		ONAME1 ONAME2	OUTNO								
6											
7		VLABLE	OUTPLT								
8											
Initial Condition			ISNDX ISNDX	IDIST			SIGMA	SIGLB	SIGUB		
Time Series			ITNDX ITNDX2	ITDIST		TPSIG	TSGMA	TLB	TUB	ITNDX2Q	TSPER
9											
10			IMVNDX								

The logic of OINPT1 reads variable values on type 3 cards directly into the specified position of the C-array in the order in which the cards are read. Hence, a previously defined element of the C-array will be overridden by the new value if the same C-index is specified on another 3-card encountered later in the data card set. Thus, an input variable can be changed in the data card set by simply adding the desired card behind the original one(s) in the set. This cannot be done, however, with the data cards other than type 3 cards. Adding an additional type 2 (module selection) card, for example, without removing the one to be replaced will cause both modules to be executed in the integration loop.

2. OUPT3 - Output Subroutines

a. Functional Description

OUPT3 controls printed output of desired data generated during integration of the missile trajectory. Specifically, OUPT3 performs the following:

1) Saves maximum and minimum values of the Y and Z components of laser designator spot jitter.

2) The C-array dump option (DOC) that allows output of the C-array at the first DOC-6 integration steps is exercised in this routine. OUPT3 checks the flag ITCNT (if ITCNT $\leq$ 6, dump C-array) to determine if a C-array dump is desired. ITCNT is set initially to DOC + 1 in OUPT2 and bumped up by 1 each pass through OUPT3 until it exceeds 6. No C-array dump is made if ITCNT is greater than 6.

3) The trajectory time (T) and integration step size (DER(1)) is printed out by OUPT3, following a change in integration step size made in the integration subroutine, AMRK.

4) Output data specified on type 4 input data cards is output from OUPT3. The symbol names located in the second and third ALPHA fields of type 4 data cards are printed out five symbols per row with double spacing between each row. This symbol block is output before the first block of output data is printed and then every two pages of print thereafter. The value of the parameters specified by the C-index on type 4 cards is printed out at each time point interval specified by the input variable, CPP. These data blocks are output until two pages of print are filled. At this time, the symbol block is reprinted, followed by a resumption of the data block output print.

b. Initialization Subroutine

OUPT2 sets KCONV, the run termination switch to zero, initializes certain output and plot flags and calls DUMPO to execute the first C-array dump if DOC < 6.

3. PLOT4-PLOT Routine

a. Functional Description

The 6 DOF simulation program has a plotting capability. However, the array (GRAPH) and the file (TAPE1) for storing and disposing of plot requested data are not a permanent part of the simulation program. Instead, a plot-package UPDATE deck and a DISPOSE card must be used when making runs requiring plots.

This approach was taken because the addition of the storage part of the plot package increased the memory requirements significantly. Thus, to keep job turn-around time in the computer as low as possible for normal runs, the plot storage package was not included as a permanent part of the program.

Plotting is done with the Houston Instrument COMPLOT Digital Incremental Plotter. This plotter is not available at the central computer site, but instead is tied to and driven on-line at various remote terminals. This means that the operation (loading paper, pens, turning on, etc.) of the plotter is left up the user.

Plot data are stored on a disc file named TAPE1. To plot, TAPE1 must be disposed of when the run is completed. This is done by placing a DISPOSE card in the job control language input stream. For example, to plot on the COMPLOT at a remote terminal logged in as GT use the following dispose card:

DISPOSE(TAPE1, PR = IGT) .

Place the DISPOSE card after the LGO card. In addition, to avoid losing plot data if an abnormal termination occurs during execution, place a DISPOSE card after the EXIT card as well.

A summary of plot capability utilization follows:

1) Use the following UPDATE package:

```
*IDENT PLOT1
*DELETE MC7.3
  .,TAPE1)  (start in card column 6)
*INSERT MC7.43
     DIMENSION GRAPH (300,15)  (start in card column 7)
*INSERT IO.165
     DIMENSION GRAPH (300,15)  (start in card column 7)
*INSERT 10.200
     DIMENSION GRAPH (300,15)  (start in card column 7)
*DELETE PLOT.6
```

2) Place a DISPOSE card after the LGO card; example,

DISPOSE (TAPE1, PR = IGT)

3) Input 7-cards and 3-cards as required. A description of 7-and 3-cards required for plotting is given in Section IV. A. 7.

b. Input/Output

Up to 15 variables may be plotted for a given trajectory simulation. Plotting is controlled by use of 7-cards with plotting options falling in two categories. The first category involves the plotting of time histories and the second involves plotting of selected pairs of variables, one against the other.

(1) Time History Plots, Y versus T. For each 7-card input, one variable (specified by the C-index on the 7-card) will be plotted against time. The time array is saved automatically. Scaling of the ordinate axis may be automatic (based on range of data in plot array) or the ordinate scale limits may be specified. The 7-card contains the following input fields:

a) 7 in card column 2.

b) Ordinate label, card column 9 to 20.

c) C-index of variable to be plotted against time, right adjusted in card columns 21 to 25.

d) Scale option, card column 27 -

0 - automatic scaling
1 - fixed scale limits.

e) Limits for fixed scale (Y-axis only) -

Upper limit, card columns 31 to 45
Lower Limit, card columns 46 to 60.

The time axis is automatically scaled based on the data range of the time array.

(2) Paired Plots, Y versus X. Any variable in the C-array may be plotted against any other variable in the C-array. This option requires a 3-card to specify the number of paired plots and 7-card for the abscissa and a 7-card for the ordinate. Thus, one paired plot requires two 7-cards. In addition, an order must be observed in reading these cards in. The order is as follows:

a) All paired plot 7-cards must be in front of all nonpaired plot 7-cards.

b) All paired plot variables must be on consecutive 7-cards.

c) The abscissa 7-card (X) must be the first 7-card in a paired plot pair.

d) The number of paired plots must be specified by 3-card input variable PLOTN2, whose C-index is 1983.

The paired plot 7-card contains the following input fields:

a) 7 in card column 2.

b) Axis label in card column 9 to 20.

c) C-index of plot variable right adjusted in card columns 21 to 25.

d) Scale option, card column 27

0 - automatic scaling
1 - fixed scale limits, ordinate only, abscissa automatically scaled
2 - fixed scale limits, ordinate and abscissa.

e) Limits for fixed scale -

Upper limit, card columns 31 to 45.
Lower limit, card columns 46 to 60.

Each variable on the paired plot 7-cards will be plotted versus time (underthe first category) before the paired plots are made. These time history plots may be suppressed by setting PLONT4 = 1. This option will eliminate all time history plots. Therefore, if this option is selected and it is desired to have some time history plots, then the time history variable and the variable time (T) will have to be treated as paired plot variables.

c. Input/Output Variables and Cross Reference of C-Array

The input/output variables and cross reference of C-array are presented in Tables 69, 70, 71.

TABLE 69. INPUT FROM DATA CARDS (3-CARD) - PLOT4

Fortran Symbol	Symbol Used in Text	C Index	Definition
PLOTN2		1983	Number of paired plots
PLOTN4		1982	Time history suppression switch - 0 - plot all paired plot variables against time 1 - plot no automatic time histories
PPP		2005	Plot sample interval (sec)
PST		2002	Plot sample start time (sec)

TABLE 70. INPUT FROM OTHER MODULES AND SUBROUTINES - PLOT4

Fortran Symbol	Symbol Used in Text	C Index	Definition
GRAPH(I,J)		None	Storage array for the Ith time point of the Jth variable to be plotted. Defined in OUPT3
TIME(I)		2025 to 2324	Storage array for the Ith time point of flight time. Defined in OUPT3

TABLE 71. OUTPUT - PLOT4

Fortran Symbol	Symbol Used in Text	C Index	Definition
			A plot file, TAPE1, contains all plot data. To plot, TAPE1 must be disposed of when the run is completed. This is done by palcing a DISPOSE card after the LGO card. For example, to plot at remote terminal GT: DISPOST (TAPE1, PR = 1GT)

IV. INPUT/OUTPUT FORMAT

A. Input

1. Introduction

Program inputs fall into ten major categories. The cateogry of each data card input is identified to the input section of the program by the card type punched in card column 1. The data categories and the corresponding card types are indicated in Table 72.

The program is designed in the deterministic mode to sequentially simulate multiple trajectory cases in a single run; or in the stochastic mode, a number of Monte Carlo runs are made (the number of runs determined by the number of 6-cards in the data deck) followed by statistical analysis performed on the data generated. An example data deck setup for a deterministic run is shown in Figure 53. A Monte Carlo deck setup is shown in Figure 54. The program input logic is structured to optionally allow the input data sets for successive cases to include only data which differs from or augments data in the immediately preceding case. Thus, for example, if case 2 differed from case 1 by only the value of the launch heading azimuth angle, then only the new value of launch heading azimuth angle would be required in data set 2.

TABLE 72. INPUT DATA CATEGORIES AND CORRESPONDING CARD TYPE

Card Type (Card COL 1)	Data Category
1	Output and staging subroutine selection
2	Module selection
3	Program parameter input values
4	Print variable selection
6	Data set termination indicator
7	Plot variable selection
8	Monte Carlo input parameter selection
9	CEPAS control information
10	Mean and standard deviation output variable selection

The program is designed in the deterministic mode to sequentially simulate multiple trajectory cases in a single run; or in the stochasitc mode, a number of Monte Carlo runs are made (the number of runs determined by the number of 6-cards in the data deck) followed by statistical analysis performed on the data generated. An example data deck setup for a deterministic run is shown in Figure 52. A Monte Carlo deck setup is shown in Figure 53. The program input logic is structured to optionally allow the input data sets for successive cases to include only data which differs from or augments data in the immediately preceding case. Thus, for example, if case 2 differed from case 1 by only the value of the launch heading azimuth angle, then only the new value of launch heading azimuth angle would be required in data set 2.

Program variables which can be set by input are initialized to zero by the program prior to reading the input cards for the first case. Consequently, program constants (constant gains, deadband angles, etc.) which are to have values of zero do not require an input card. Program variables which are to be initialized to zero, but varies during simulation, however, will require an input card with the initial value reset flag set if multiple cases are being run, and the desired initial value of the variable is zero for each case.

The program input logic does not require that the cards be arranged according to card type sequence. Thus, type 1, type 2, etc., cards can appear anywhere in a data set; cards of a given type can even be separated by different card types. The order of appearance of the type 2 (module selection cards), however, dictates the execution order of the modules during a simulation. Because the module execution order is critical to a valid simulation, the order of appearance of the type 2 cards within a data set must be as specified in Section IV. A. 3.

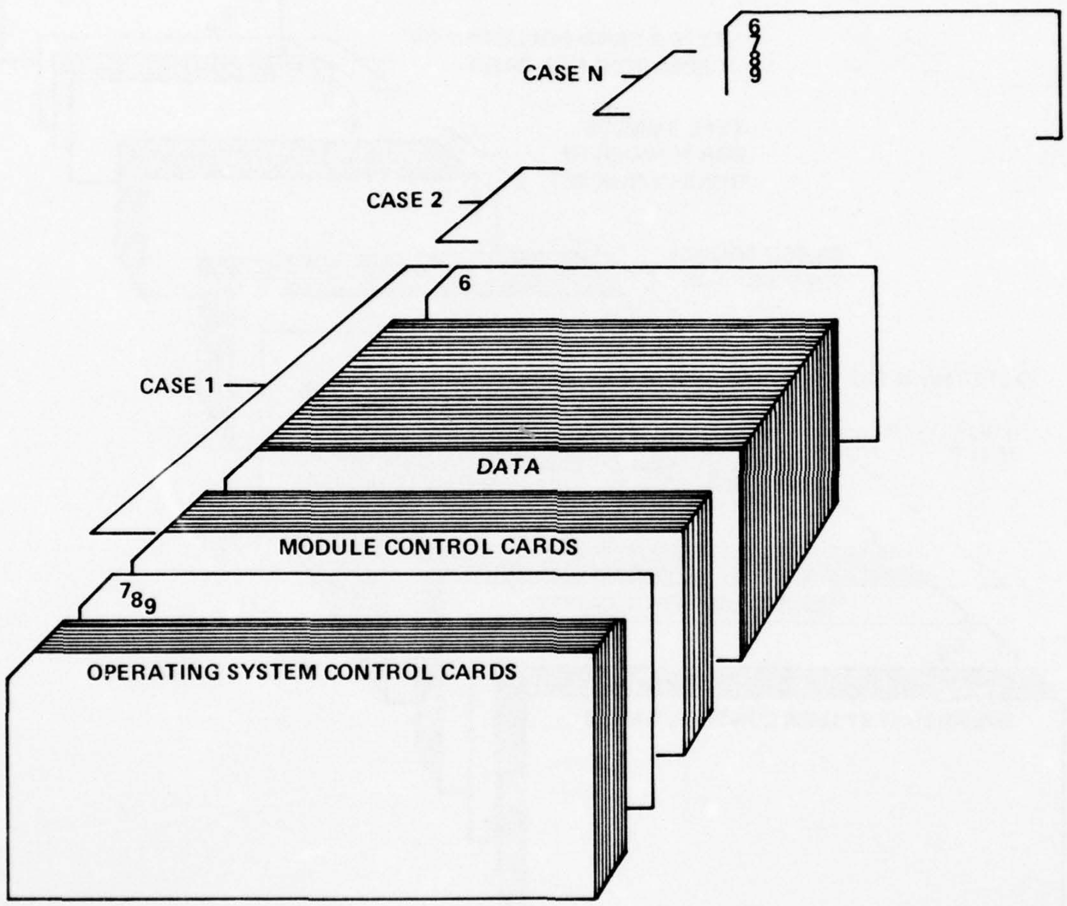


Figure 52. Deterministic deck setup.

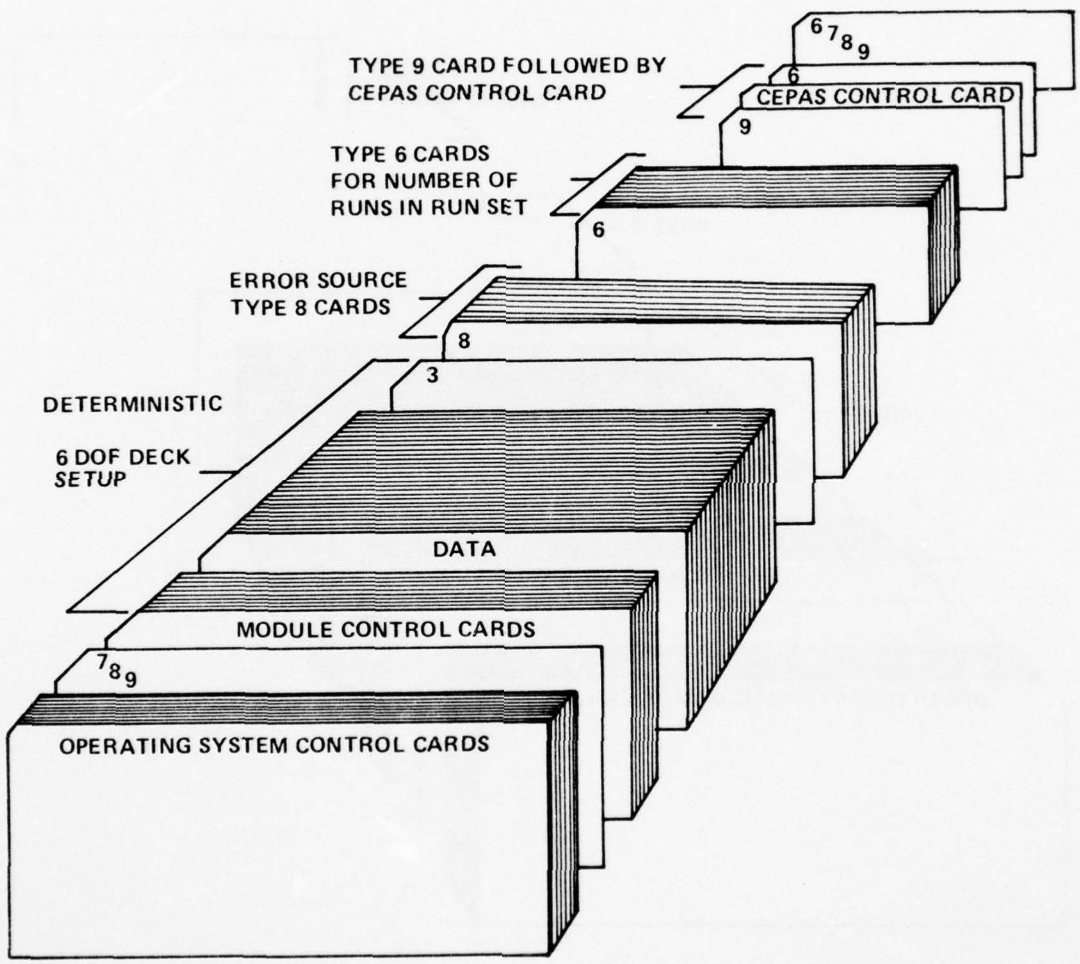


Figure 53. Monte Carlo deck setup.

As was previously mentioned, the number of runs in a Monte Carlo run set is controlled by the number of 6-cards in the data deck. CEP calculations are controlled by a 9-card (Figure 53). CEPAS information and type 9 cards are handled differently from all other card types. In this case, no other information other than card type number is punched on this card. The CEPAS control parameter card is placed immediately following the type 9 card. The type 9 card and CEPAS control parameter card are then placed in front of the last type 6 card.

2. Card Type 1 - Output and Staging Subroutine Selection

Data entered on type 1 cards controls, in principle, which output and staging subroutines are used during a mimulation. With the current configuration of the program, however, only one option is available. Therefore, the type 1 cards must be input as shown in Figure 54 (the order of appearance in the deck is unimportant).

3. Card Type 2 - Module Section

Data entered on type 2 cards determines which modules will be executed during a simulation. Moreover, as previously mentioned, the order of appearance in the deck of the type 2 cards determines the order of module execution. Therefore, the cards must be input in the order as illustrated in Figure 55. The winds module (G2) cards can be omitted if a run is to be made with no winds.

The module name field is used for data identification only. Any name, comment, etc., can be entered in this field. The module number must be the number (shown) recognized by the program.

4. Card Type 3 - Program Parameter Input Values

The type 3 cards specify initial parameter variable values. If the reset flag is set to 1, the program will reset the variable to the input value at the end of the case corresponding to the data set. Any subsequent cases, therefore, will use the same initial variable value, until a data set is encountered which changes the initial value. If multiple cases are being run, each variable that changes its value during the simulation should either have the reset flag set or have an initial value defined for each case; otherwise, cases after the first will be initiated with the variable equal to its terminal value in the preceding case.

Initial values from type 3 cards are read directly into a single array using the number entered in column 21 through 25 as the array subscript. Therefore, the index value must be right justified and represent the correct array index. Table 73 shows the array index for each input variable. The name field is for print identification only. Because the initial value data on type 3 cards is read directly into the location in the variable array specified on the card, two or more type 3 cards with the same index entry will result in all but the last input value being obliterated. The last encountered value will be the one used for the parameter initial value.

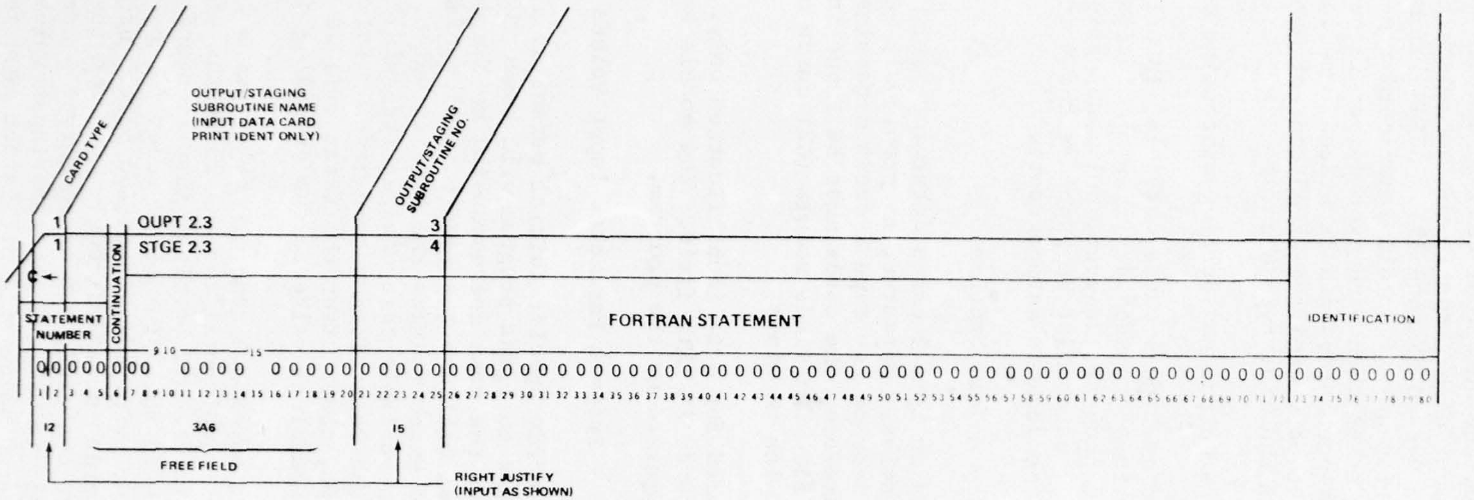


Figure 54. Type 1 card format.

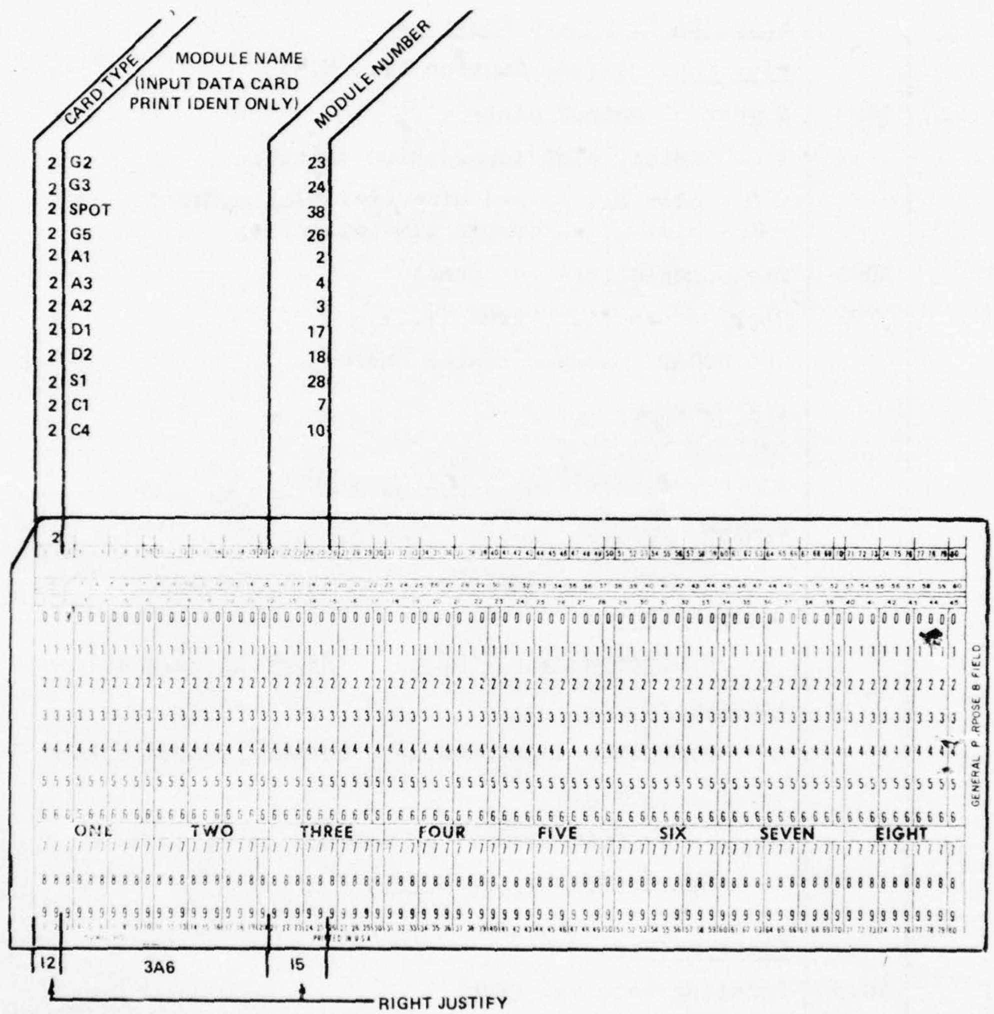


Figure 55. Type 2 card format.

TABLE 73. INPUT DATA

Fortran Symbol	C Index	Definition
		Input to Executive Routines
		Plot Control (see Section III. E. 3)
PLOTN2	1983	Number of paired plots
PLOTN4	1982	Time history plot suppression switch: 0 - plot all paired plot variables against time 1 - plot no automatic time histories
PPP	2005	Plot sample interval (sec)
PST	2002	Plot sample start time (sec)
		Use UPDATE package listed below. *IDENT PLOT1 *DELETE MC7.3 ., TAPE1) (Start in card column 6) *INSERT MC7.43 DIMENSION GRAPH(300,15) (Start in card column 7) *INSERT IO.165 DIMENSION GRAPH(300,15) (Start in card column 7) *INSERT IO.200 DIMENSION GRAPH(300,15) (Start in card column 7) *DELETE PLOT.6 Place a DISPOSE card after the LGO card; example DISPOSE(TAPE1, PR = IGT)
		Print Control
CPP	2015	Printing interval (sec)
DOC	2013	Allows dumping of C-array for the first (6 DOC) integration intervals (normally input 6.)
OPTN10	2022	C-array dump option end of run: 0 - no C-array dump 1 - dump C-array at end of run
		Integration Parameters
T	2000	Initial value of flight time (sec)
TF	2001	Maximum allowable flight time (sec)

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THAD T-7 MISSILE MONTE-CARLO TERMINAL HOMING SIMULATION UTILIZI--ETC(U)
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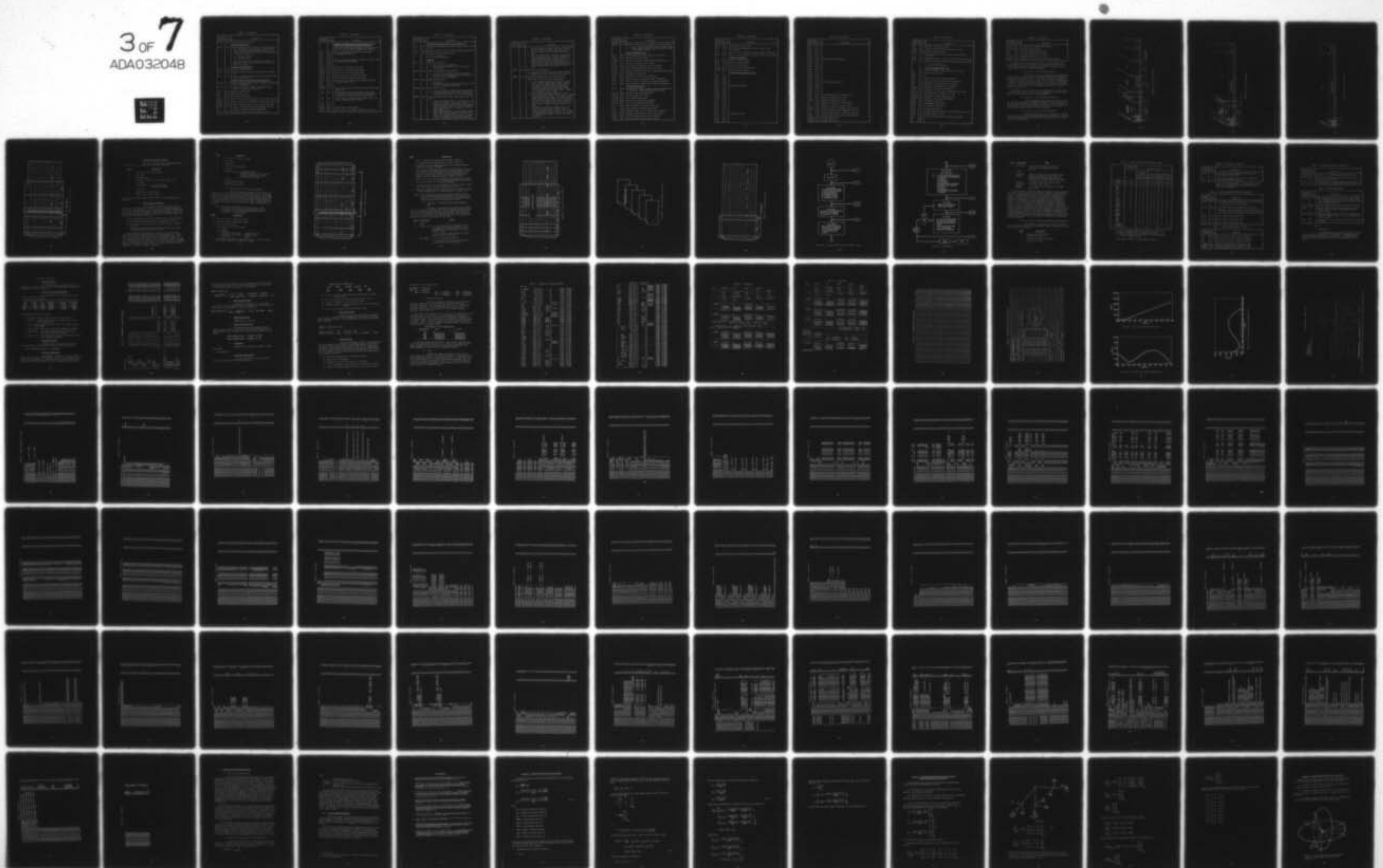

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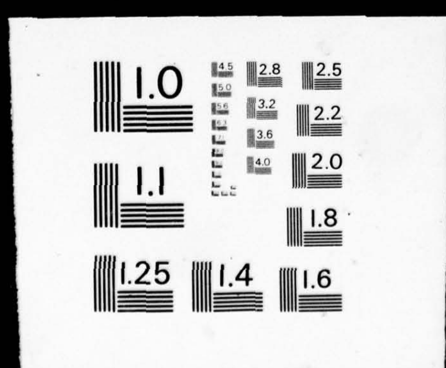

TABLE 73. (Continued)

Fortran Symbol	C Index	Definition
DER(1)	2664	Integration step size (sec)
		<u>Multiple Run Control</u>
STEP	2010	Flag that indicates the nature of the next case to be run. STEP may take on any one of eleven values. The input value of STEP determines the point in MAIN at which the next case will be start execution. Normal input values are: 2 - normal run follows 11 - terminate case (The entry point in MAIN based on the value of STEP is indicated in Figure 64 for all values of STEP from 1 to 11)
		<u>Constants for Simulation</u>
AGRAV	1627	Gravity constant (ft/sec)
RHZRO	1665	Distance of earth fixed coordinate above sea level (ft)
CRAD	1751	Radians to degrees conversion factor (57.295778 hard-wired in module D1I)
		<u>Missile Weight, Engine, and Airframe Parameters</u>
QNALGN	1403	Engine misalignment option switch (QNALGN > 0) selects engine misalignment)
QBURN	1405	Engine burnout switch (QBURN > 0) signals engine burnout at simulation initiation)
CISP	1414	Specific impulse (sec)
DWT	1415	Missile weight (lb)
DWP	1416	Propellant weight (lb)
RDCGO	1417	Launch value of CG dispalcement along X-body axis (ft)
RDCGF	1418	Burnout value of CG displacement along X-body axis (ft)
FMIXO	1419	Initial moments of inertia about X and Y body axes
FMIYO	1420	(Due to assumed missile axis symmetry, FMIZF is taken to be equal to FMIYF) (slug-ft^2)
RLCGO	1431	Distance between launch CG and REAR lug (ft)

TABLE 73. (Continued)

Fortran Symbol	C Index	Definition
		Missile and Target Initial Position and Velocity Values and Missile Initial Attitude Setting
		(Input of the following parameters is governed by the two input options, OPTN2 and OPTN4; see Table 74.
RXE	1515	Initial components of missile in earth fixed coordinate system (ft)
RYE	1619	
RZE	1623	
VXE	1603	Initial velocity components of missile in earth fixed coordinate system (ft/sec)
VYE	1607	
VZE	1611	
BPSIO	1754	Initial body yaw Euler angle (deg)
BTHTO	1753	Initial body pitch Euler angle (deg)
BPHIO	1752	Initial body roll Euler angle (deg)
BTHTG	427	Initial seeker pitch gimbal angle (deg)
BPSIG	431	Initial seeker yaw gimbal angle (deg)
RTXE	1651	Target position in earth fixed coordinate system (normally zero) (ft)
RTYE	1655	
RTZE	1659	
RSLANT	1667	Initial magnitude of the line-of-sight vector (slant range) (ft)
BSLOV	1666	Initial value of the line-of-sight vector angle (measured in a vertical plane from missile local horizontal to the line-of-sight vector (deg).
VWXE	100	Initial velocity components of a steady wind in the earth coordinate system (ft/sec)
VWYE	101	
VWZE	102	
VMACH	204	Initial value of Mach number
VMWTE	1674	Initial velocity of missile relative to the wind

TABLE 73. (Continued)

Fortran Symbol	C Index	Definition
		Launcher Parameters (Input Only if OPTN4 > 0)
RAIL	1317	Rail length (between rear of front lug and end of rail) (ft)
RLUG	1316	Spacing between front and rear missile launch lugs (ft)
VIB	626	Launch transient vibration flag: 0 - no vibration 1 - run with vibration
		Options
OPNW	50	Wind option selector: 0 - no winds (no input required) 1 - steady winds (see Table 75) for input data requirements
QNALGN	1403	Thrust misalignment option selector: 0 - no thrust misalignment (no inputs required) 1 - compute thrust misalignment forces (see Table 75 for input data requirements)
QBURN	1405	Engine burnout switch: 0 - engine burn 1 - initialize trajectory after engine burnout (see Table 77 for additional inputs)
OPTARG	1639	Target motion option: 0 - no target motion (no additional input required) 1 - integrate target motion to update target position (see Table 70 for input data requirements)
OPTN2	3502	Initial position and velocity input option (see Table 74) 0 - input position and velocity of missile and input position of target. Input Euler angles of missile and seeker gimbal angles. Input missile initial velocity relative to the wind (VMWTE or VMACH) and wind velocity components (if wind option OPTNW = 1) 1 - input RSLANT and BLSOV. Initial position components (RXE, RZE) are computed from RSLANT and BSLOV. RYE automatically set to zero. Initial velocity components (VXE, VYE, VZE) computed from the wind velocity (VWXE, VWYE, VWZE which

TABLE 73. (Continued)

Fortran Symbol	C Index	Definition
		must be input) and missile velocity relative to the wind (VMACH or VMWTE, which also must be input). Target position automatically set to zero 2 - input initial position components RXE and RZE (RYE automatically set to zero). RSLANT computed from RXE and RZE. Initial velocity components (VXE, VYE, VZE) computed from wind velocity and missile velocity relative to the wind (VMACH or VMVTE, which also must be input.) Initial target position automatically set to zero
OPTN3	3503	Roll rate option selector: 0 - compute roll rate from moments about roll axis 1 - maintain roll rate at zero or input constant
OPTN4	3504	Rail launch dynamics and fire selector option: (see Table 74 for input data requirements) 0 - no rail dynamics compute; direct fire. Input initial seeker gimbal angles (BTHTG, BPSIG). The initial body Euler angles (BPSIO, BTHTO) are computed from the seeker gimbal angles under the constraint that the X-gimbal axis points along the line-of-sight vector. (BPHIO is automatically set to zero) 1 - rail dyanmics computed; direct fire. Input initial body Euler angles (BPSIO, BTHTO). (BPHIO automatically set to zero). The initial seeker gimbal angles (BTHTG, BPSIG) are computed from the initial body Euler angles under constraint that the X-gimbal axis points along the line-of-sight vector. (BPHIO is automatically set to zero) 2 - rail dynamics computed; indirect fire. Input initial body Euler angles (BPSIO, BTHTO). (BPHIO automatically set to zero). The seeker is automatically caged at the input initial gimbal angle values. (BPSIG, BTHTG) until target acquisition

TABLE 73. (Continued)

Fortran Symbol	C Index	Definition
OPTN6	3506	Missile initial velocity (relative to wind) option:
		0 - input missile initialmach number (VMACH, C(204)) 1 - input missile initial velocity relative to the wind (VMWTE, C(1674))
		<u>Seeker Parameters - S1</u>
DT	446	Laser designator pulse repetition time (sec)
SWP	452	Autoerection drift factor
RLOCK	445	Maximum quandrant tracker acquisition range (ft)
BDB	447	Tracker deadband at 10 km (deg)
CFOVZ	448	Total seeker field-of-view in pitch (deg)
CFOVY	449	Total seeker field-of-view in yaw (deg)
GSX	450	Seeker quadrant tracker error signal acquisition gain
SEPS	451	Integrator drift rate
GS	456	Quadrant tracker error signal gain
WSL	457	Zero location of integrator lead compensation
WSN	458	Pole location of additional lead-lag compensation
WL2	459	Zero location of additional lead-lag compensation
		<u>Autopilot Parameters</u>
TDY	866	Minimum time before trajectory pitch program will be switched to terminal homing guidance (sec)
GBIAS	854	Gravity bias program (deg/sec)
HLIMO	850	Pitch command limit (deg)
HLIME	851	Yaw command limit (deg)
QBIAS	852	Pitch rate command bias (deg/sec)
RBIAS	853	Yaw rate command bias (deg/sec)
GZ	867	Pitch navigation guidance filter gain
GY	855	Yaw navigation guidance filter gain
WP1	861	Complex pole of roll control filter (rad/sec)
DP1	862	Damping coefficient of roll control filter
TAUZ	863	Pitch navigation filter pole (rad/sec)
TAUY	864	Yaw navigation filter, pole (rad/sec)

TABLE 73. (Continued)

Fortran Symbol	C Index	Definition
HLIMP	865	Roll command limit (deg)
WQ1	871	Pitch and yaw compensation filter complex pole (rad/sec)
DQ1	872	Pitch and yaw compensation filter damping coefficient
TAUL	877	Pitch and yaw navigation guidance filter zero (rad/sec)
		Acutator Parameters
BDP	1231	Roll fin setting (deg)
BDQ	1232	Pitch fin setting (deg)
BDR	1233	Yaw fin setting (deg)
WDELTL	1143	Actuator rate limit (deg/sec)
GDELT	1144	Actuator pole (rad/sec)
		Optional Seeker Models - S2, S3
KQ1	545	
KQ2	547	
KQ3	549	
KQ5	551	
KQ6	553	Pitch channel gains
KQ7	555	
KQ8	557	
KQ10	559	
KQ11	561	
KQ12	563	
KR1	546	
KR2	548	
KR3	550	
KR5	552	
KR6	554	
KR7	556	Yaw channel gains
KR8	558	
KR10	560	
KR11	562	

TABLE 73. (Continued)

Fortran Symbol	C Index	Definition
DR12	564	
WTQ1	573	
WTQ2	575	
WGQ1	577	
WGQ3	581	
WGQ4	583	Pitch channel frequencies
WGQ5	585	
WGQ6	587	
WRQ2	591	
WRQ4	595	
WTR1	574	
WTR2	576	
WGR1	578	
WGR3	582	
WGR4	584	Yaw channel frequencies
WGR5	586	
WGR6	588	
WRR2	592	
WRR4	596	
RCL	597	Rate command limit in pitch and yaw
TCLQ	598	Torque command limit in pitch
TCLR	599	Torque command limit in yaw
JI	565	Moment of inertial of inner gimbal
JO	566	Moment of inertia of outer gimbal
GEOCS	497	Rate gyro gain to autopilot, pitch and yaw
FRI	567	Inner gimbal friction coefficient (in.-oz)
FRO	568	Outer gimbal friction coefficient (in.-oz)
FFOV	604	Blind range decimal percent field-of-view
TARHT	601	Target height (ft)
TARWD	602	Target width (ft)

TABLE 73. (Continued)

Fortran Symbol	C Index	Definition
TAU	600	Seeker sample period (sec)
TLAG	606	Optical contrast seeker transport lag (sec)
WPTO	1738	Tipoff rate (deg/sec)
AMP2	1742	Peak amplitude of pitch moment forcing function (ft/lb)
AMP1	1746	Peak amplitude of yaw moment forcing function (ft/lb)
VIB	626	Launch transient vibration flag (pitch and yaw only): 0 - no vibration 1 - run with vibration
		<u>Optional Seeker Model - S4</u>
DT	446	Laser designator pulse repetition rate (sec)
GS	456	Detector output gain
SEPS	451	
SWP	452	Sprint restraining torque constant
WSL	457	Lead integral compensation zero (rad/sec)
WSN	458	Platform compensation role (rad/sec)
WL2	459	Platform compensation zero (rad/sec)
CROSS	506	Gimbal cross-coupling coefficient
BLUR	519	Diameter of laser spot on seeker detector (deg)
CKNULL	523	Proportionality constant to 0 null
STOTSW	524	Digital to linear switching point
STOTMX	525	Detector output limiter (deg/sec)
RDES	526	Designator range (ft)
HEES	527	Designator altitude (ft)
RVIS	529	Visibility (statue mi)
CPT	530	Target reflectivity
ETHR	531	Threshold energy density at seeker operative (J/km^2)
EDES	532	Laser designator energy
WCZ	500	Guidance filter natural frequency (rad/sec)
WF	502	
BF	505	

TABLE 73. (Concluded)

Fortran Symbol	C Index	Definition
CZETA	507	Guidance filter damping coefficient
SGBIAS	509	Seeker g-bias (deg/sec)
WCN	518	Guidance filter pole (rad/sec)
WCL	510	Guidance filter zero (rad/sec)
SGSTOT	511	Standard deviation of S/T ratio
GSLIM	539	Seeker output rate limits for linear operation

A sample type 3 card placing an initial value of zero into the program variable array at location 367 is shown in Figure 56. The 1 in the reset flag field will cause the variable to be restored to an initial value of zero for subsequent cases.

5. Card Type 4 - Print Variable Selection

The values of up to 50 variables can be reprinted at user specified simulation flight time intervals (CPP is the input print interval variable; see Table 73). The array index of each variable to be printed is entered on a type 4 card. In this case, the variable name is placed in columns 9 through 20 (rather than 3 through 20 as in types 1, 2, and 3 cards), and this name appears in the printout to identify the variable. The print order will correspond to the order of the type 4 cards in the data set.

An example of a type 4 card is shown in Figure 57, indicating that the value in the 352nd location of the variable array is to be printed and is to be identified by the name "PHI MISSILE."

6. Card Type 6 - Data Termination Indicator

This card signals the program that the end of a data set has been encountered. Include one at the end of each data set or one for each Monte Carlo run desired. (Example: for 25 run Monte Carlo set, 25 type 6 cards would be included at the end of the data set.) An example of a type 6 card is shown in Figure 58.

7. Card Type 7 - Print Variable Selection

Plotting options fall into two categories: (a) time history plots and (b) plots of selected pairs of variables. The format is shown in Figure 59 and a description of each data field for the two types of 7-cards follows:

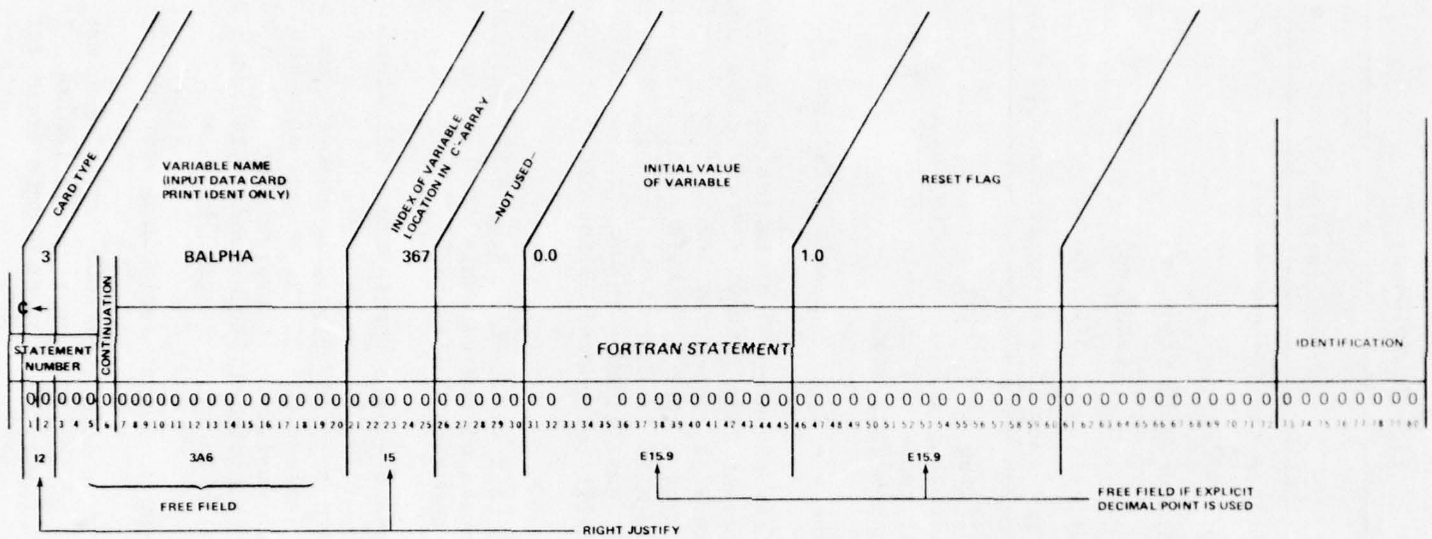

Figure 56. Type 3 card format.

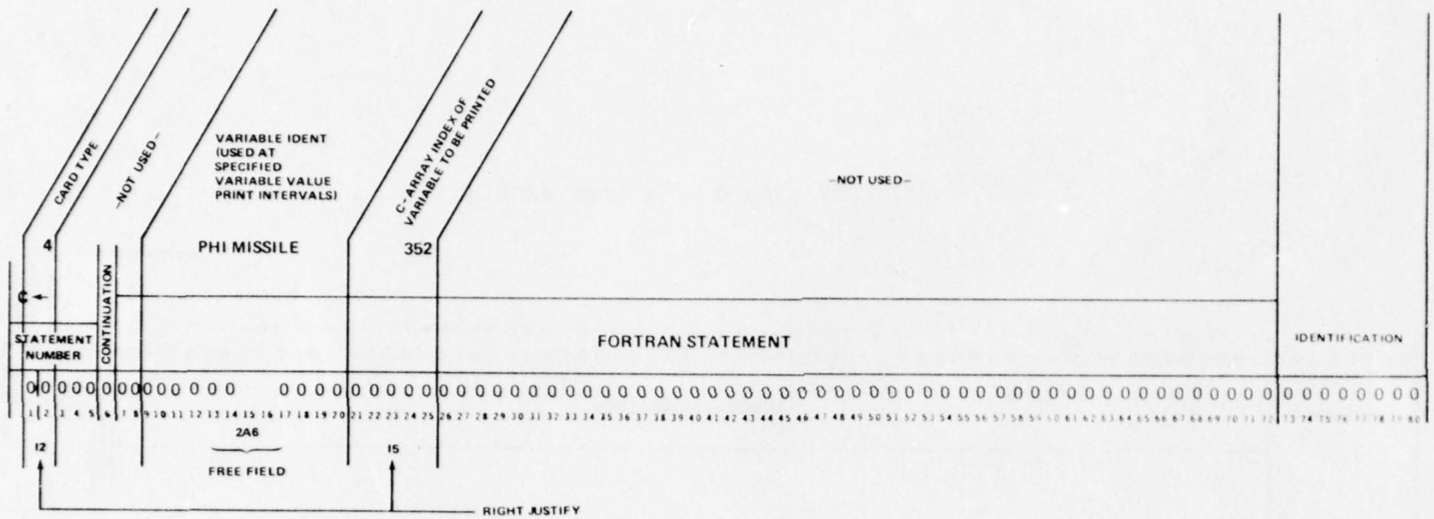

Figure 57. Type 4 card format.

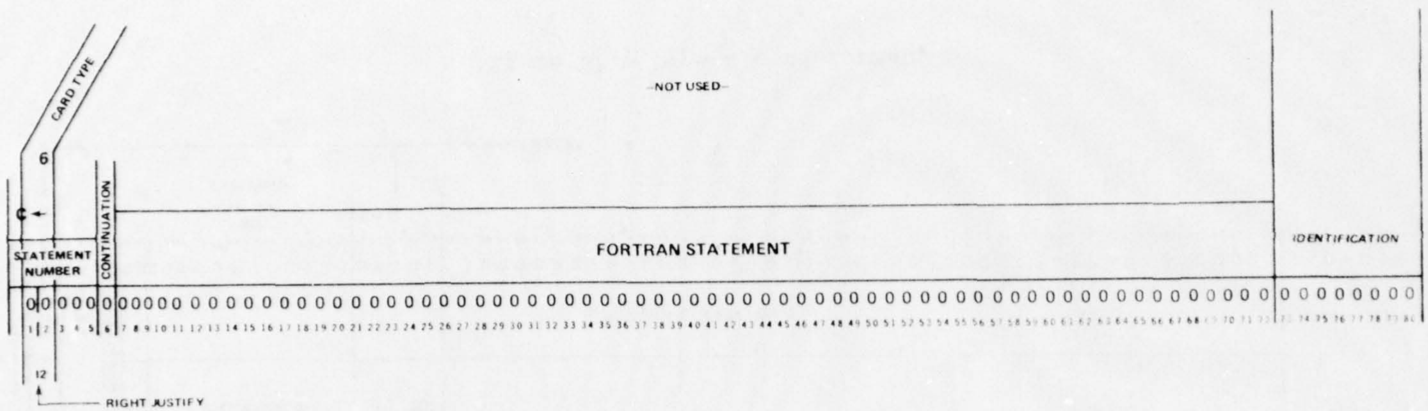

Figure 58. Type 6 card format.

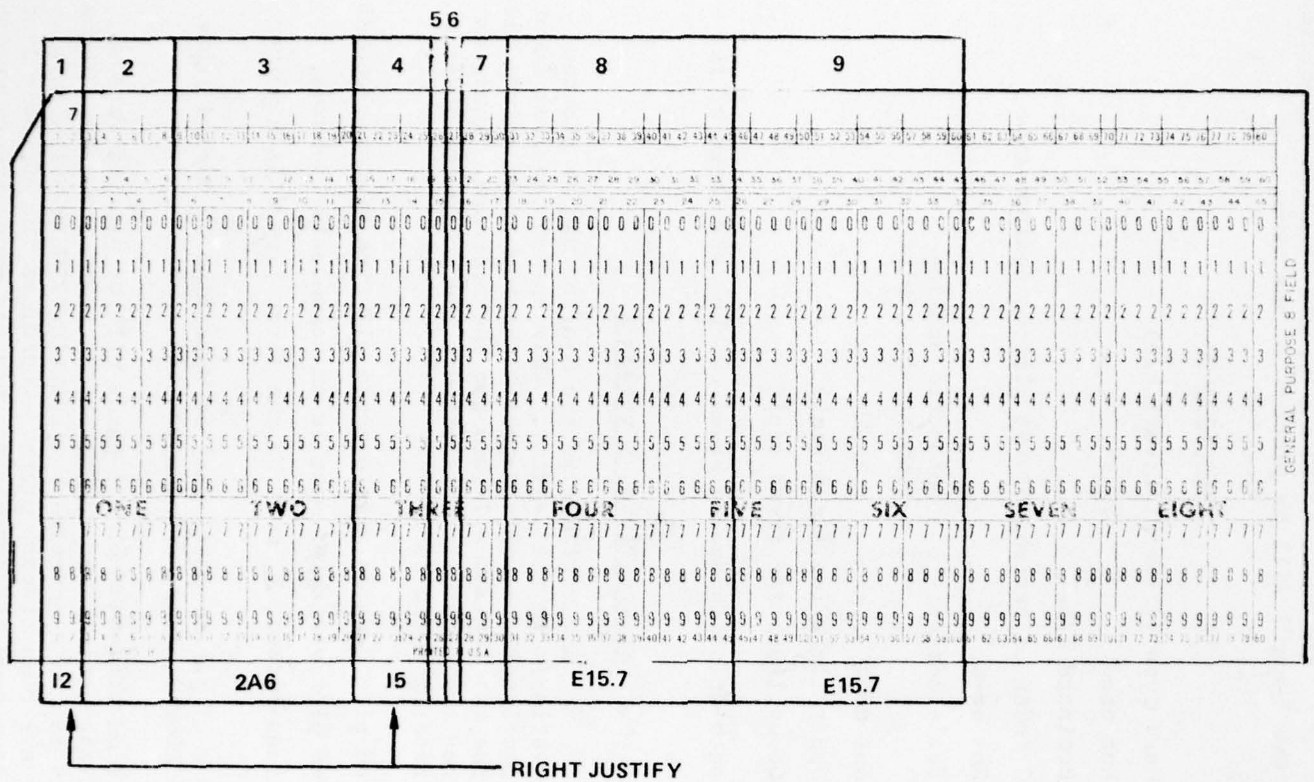

Figure 59. Type 7 card format.

a. Time History Plots, Y versus T

For each 7-card input, one variable (specified by the C-index on the 7-card) will be plotted versus time.

Field	Description
1	Card type (7 for plot variable)
2	Not used
3	Ordinate label
4	C index of variable to be plotted against time
5	Not used.
6	Scale option: 0 - automatic scaling 1 - fixed scale limits
7	Not used
8	Upper limit for fixed scale
9	Lower limit for fixed scale

The time axis is automatically scaled based on the data range of the time array.

b. Paired Plots, Y versus X

Any variable in the C-array may be plotted against any other variable in the C-array. This option requires input of a 3-card (see Section IV. A. 4) to specify the number of paired plots and a 7-card for the abscissa and a 7-card for the ordinate. Thus, one paired plot requires two 7-cards. In addition, the following order must be observed when reading these cards:

1) All paired plot 7-cards must precede all time history 7-cards.
2) All paired plot variables must be on consecutive 7-cards.
3) The absciasa 7-card, X, must be the first 7-card in a paired plot pair.
4) The number of paired plots must be specified by 3-card input variable PLOTN2, whose C-index is 1983.

Each variable on the paired plot 7-cards will be plotted versus time (under the first option) before the paired plots are made. These time history plots may be suppressed by inputting PLOTN4 = 1. This option eliminates all time history plots. Therefore, if PLOTN4 = 1 and it is desired to have time history plots, then the time history variable and the variable time (T) will have to be treated as paired plot variables. Additional variables that must be input by 3-card when using the plot capability are listed in Tables 73 through 79.

Field	Description
1	Card type (7 for plot variable)
2	Not used
3	Axis label
4	C-index of plot variable
5	Not used
6	Scale option: 0 - automatic saaling 1 - fixed scale limits, ordinate only, abscissa automatically scaled 2 - fixed scale, both axes
7	Not used
8	Fixed scale upper limit
9	Fixed scale lower limit

8. Card Type 8-Monte Carlo Input Variables

Card type 8 is used to select an error source for randomization (Figure 60). The error source identified by the 8-card must be one of the variables listed in the Monte Carlo input data tables given at the end of each module section. If the variable is not given in any of the tables, then it may be incorporated into the program by the instructions given in Section III. C. 6. Error sources called out on 8-cards that are not in the program will simply be ignored by the program.

NOTE: One 8-card corresponds to one error source. Thus, an 8-card must be input for each error source to be randomized. If no 8-cards are input, then the run is assumed to be deterministic.

Field	Description
1	Card type (08) for Monte Carlo input)
2	Error source name (information only).
3	C-index of error source
4	Type distribution of error source: 0 - normal 1 - uniform 2 - Y-component spot jitter — Correlated normal 3 - Z-component spot jitter — (filtered white 4 - wind gusts — noise)
5	Type period for time series sampling if input is for time series error source (ignored if field 11 is blank)

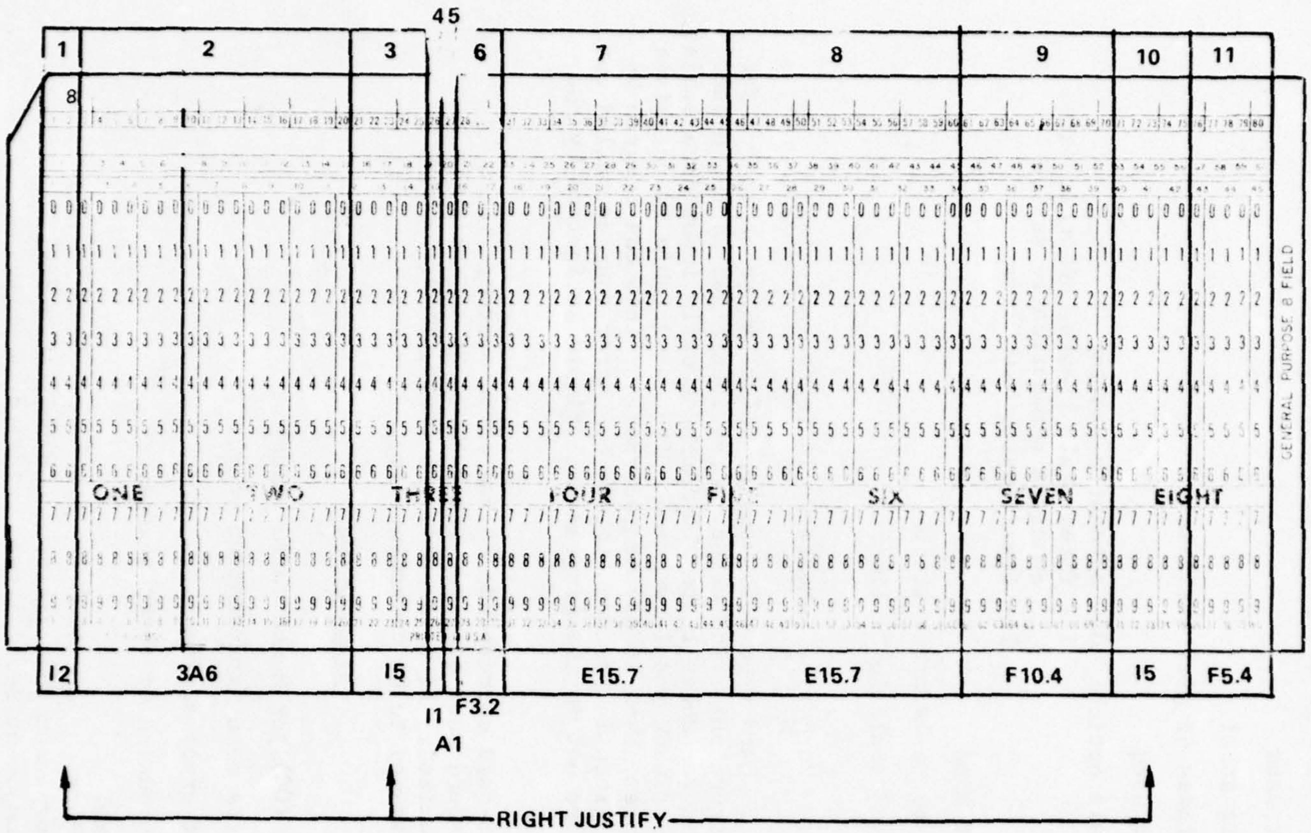

Figure 60. Type 8 card format.

Field	Description
	Blank - regular period aampling with period = field 11
	R - samplnng period random normal with mean = field 11
6	Standard deviation of sampling period if time series parameter (field 11 not blank) and field 5 = 4
7	Error source standard deviation if normal distribution; an interval multiplier if uniform distribution (if distrubution is uniform, the lower error bound will be less than the mean by the product of field 7 and field 8, and the upper bound will be greater than the mean by the product of field 7 and 9)
8	Error source lower bound — In standard deviations from the mean if normal distribution, or as defined by 7, if uniform
9	Error source upper bound — In standard deviations from the mean if normal distribution, or as defined by 7, if uniform
10	C-index of location to store random error value (if blank, random error value store in location specified by field 3)
11	Time series sample period if periodic sample rate (field 5 blank), or mean of sample period if random sample rate (field 5 = R)

NOTE: The distinction between an initial error source 8-card and a time series error source 8-card is made by the input in field 11. If field 11 is left blank, the program interprets the 8-card as a time series error source.

9. Card Type 9 - CEPAS Flag and Control Parameter Card

The input card format for the CEPAS control parameter card is shown in Figure 61. The control parameter card must follow a type 9 card as shown in Figure 62. Both of these cards (the type 9 card and control parameter card) must be placed in front of the last type 6 card in the data deck as shown in Figure 63. The multiple case entry point in MAIN step is drawn in Figure 64.

Field	Description	Value
1	Unused	
2	Normal switch	0 - use bivariate normal assumption only if data passes K-S test for normality - use/ nonparametric CEP calculation if data fails normality test
		1 - use bivariate normal assumption regardless of outcome of K-S test
3	Plot switch	0 - if no printer plots desired
		1 - if printer plots of CEP and confidence circles and impact points desired

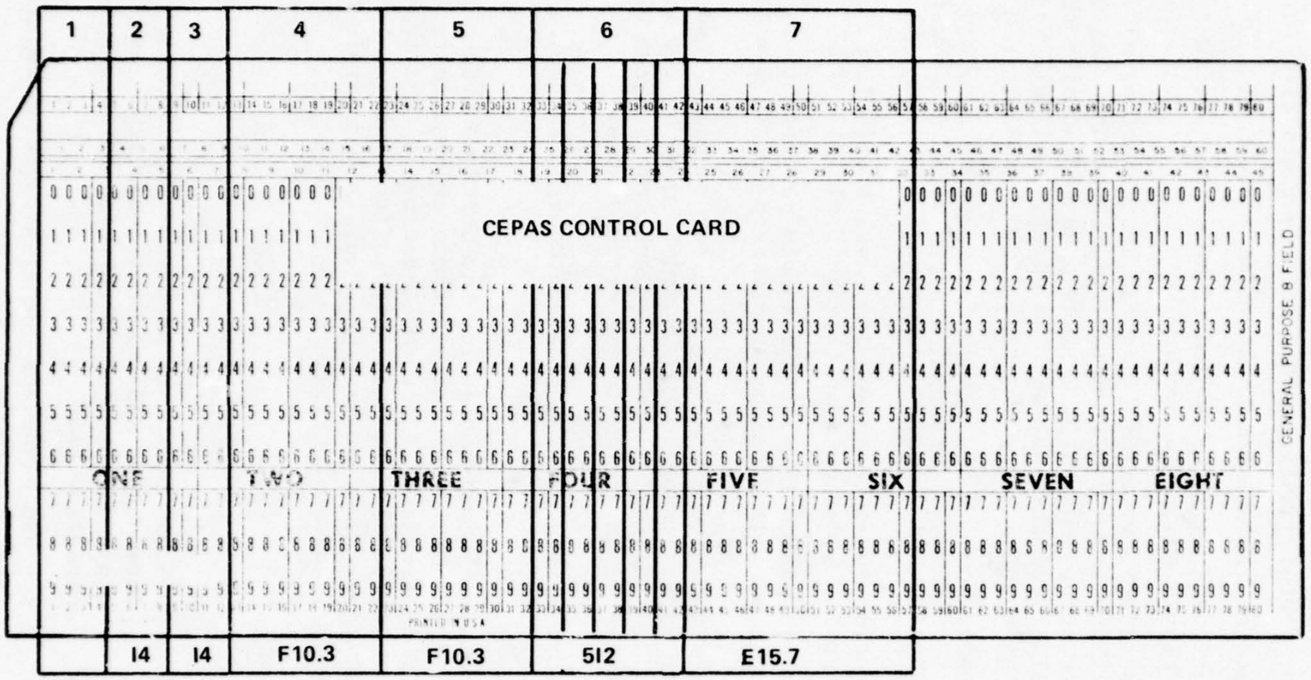

Figure 61. CEPAS control card format.

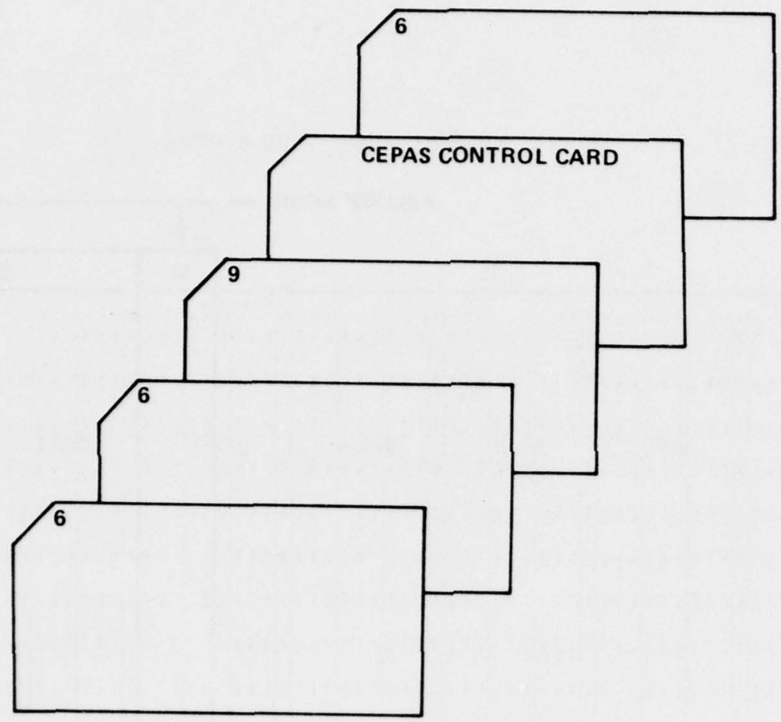

Figure 62. Control parameter card setup.

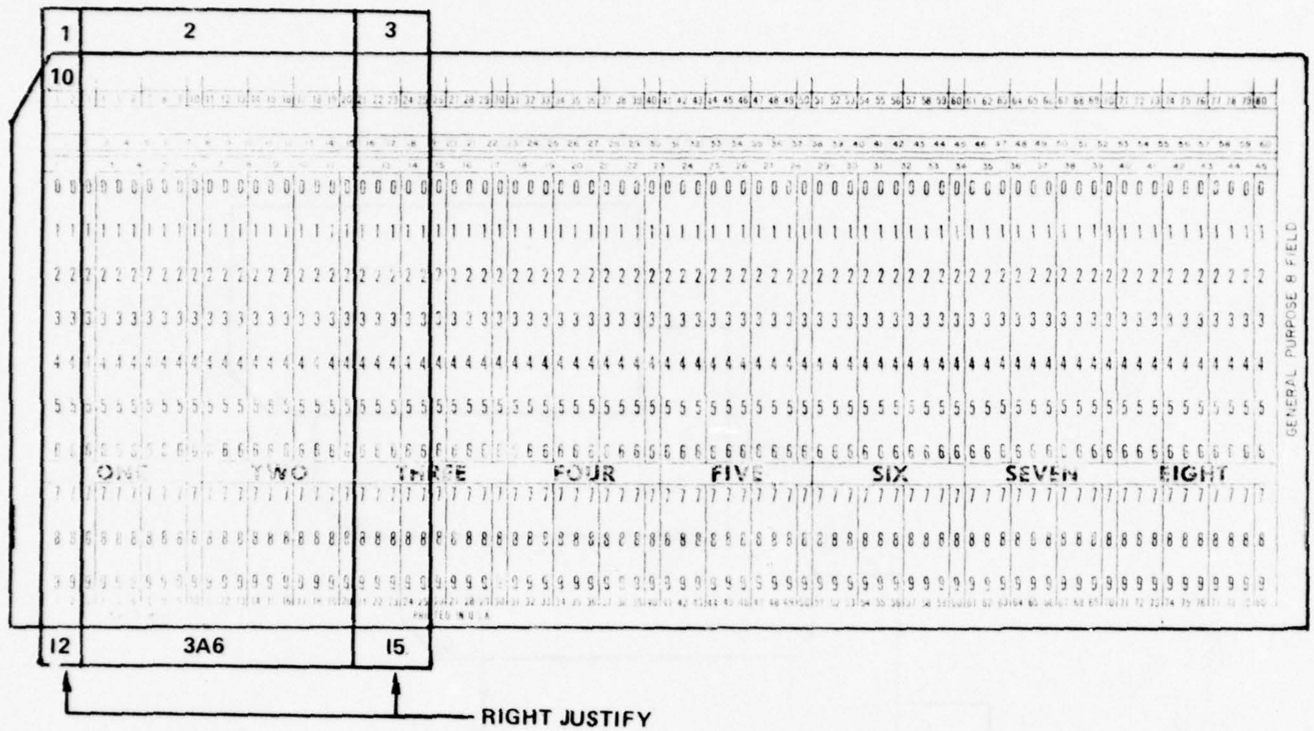

Figure 63. Type 10 card format.

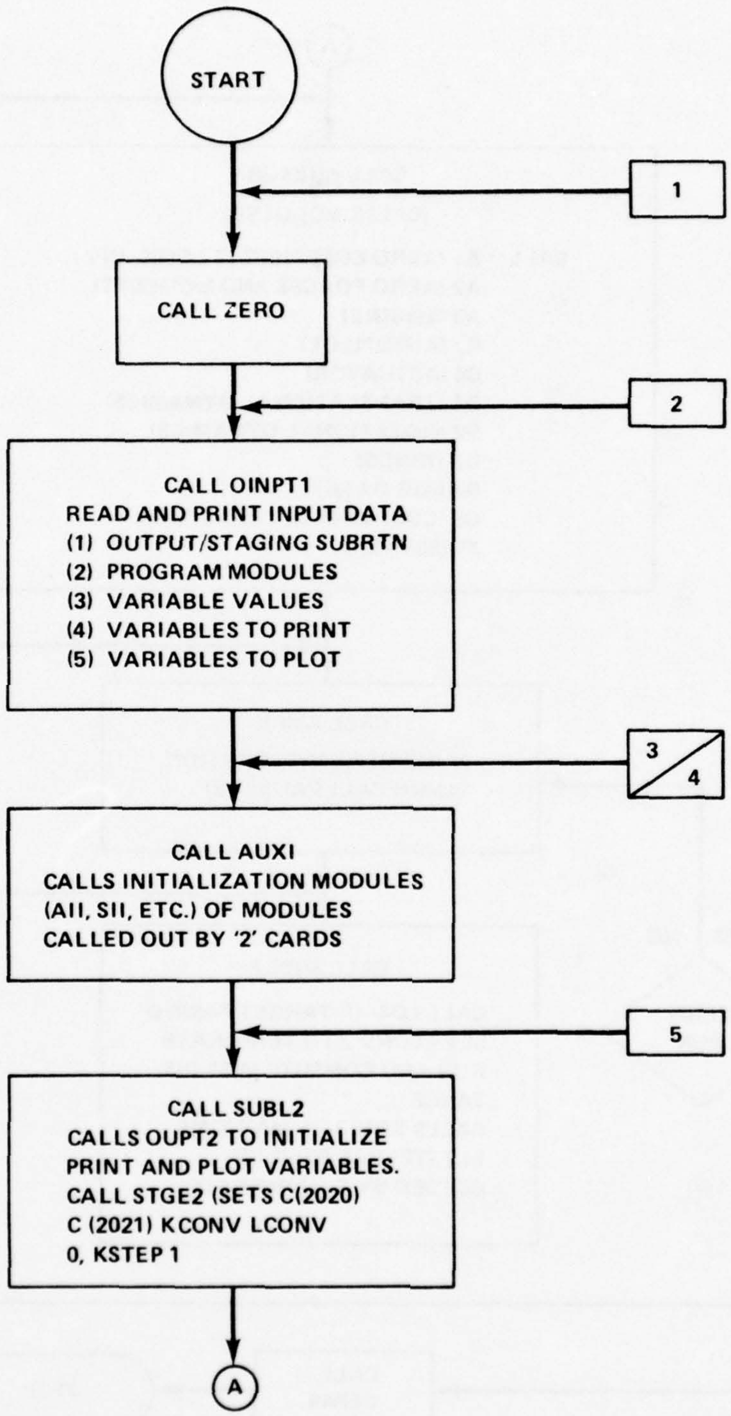

Figure 64. Multiple case entry point in MAIN - step.

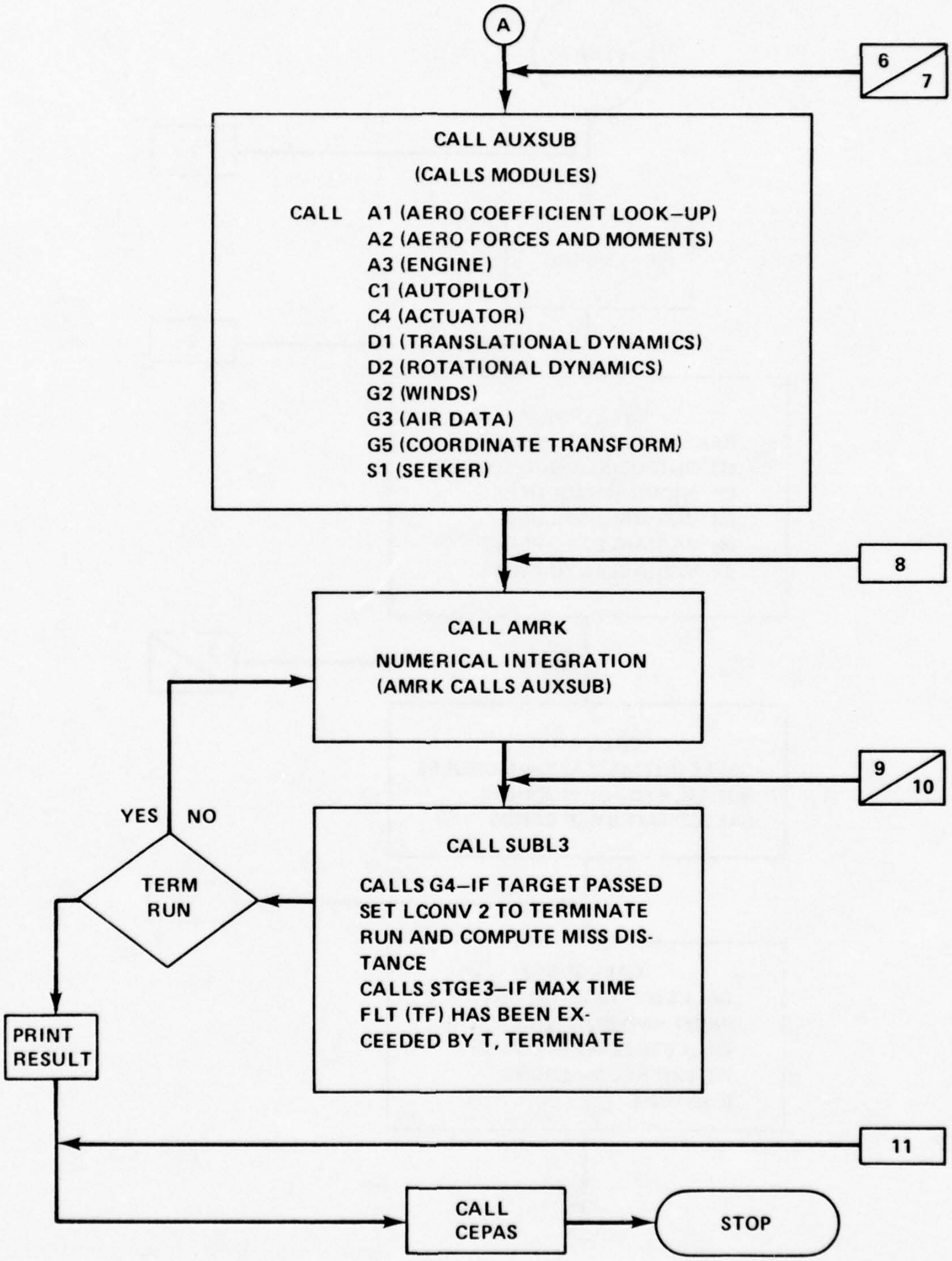

Figure 64. (Continued).

Field	Description	Value
4	Lambda (λ)	Set equal to assumed ratio of 6 DOF program CEP to missile system CEP ($\lambda \geq 0$)
5	Unused	
6	Confidence levels	Enter any combination of available confidence levels (99%, 95%, 90%, 80%, 70%) for which a confidence circle radius is desired (left justify; enter in any order)
7	Printer plot scale factor (PSIZE)	0 - Scale printer plots automatically according to data range > 0 - Scale plots according to the number input here

The CEP calculations made by CEPAS are obtained by either parametric statistical methods, assuming an elliptical bivariate normal distribution, or by nonparametric methods, where no specific distribution is assumed. Because more information can generally be obtained (e.g., confidence circles) from a given size sample when the distribution is known, it is advantageous to use the parametric methods when they apply. For this reason, CEPAS automatically subjects the input miss distance data to a normality test [(K-S) test is used] to determine whether to use the parametric or nonparametric methods. If the hypothesis of normally distributed data is not rejected by the K-S test, the parametric method is used; otherwise, the nonparametric method is used. A user option is available which causes the parametric calculations to be used regardless of the outcome of the K-S test. If this option is utilized, however, and the actual underlying population of miss distance coordinates is significantly non-normal, the resulting CEP information will be unreliable.

10. Card Type 10 - Mean and Standard Deviation Selection

The format and a description of each data field for the type 10-cards follows. The 10-cards may appear anywhere in the data deck and may be in any order.

Field	Description
1	Card type (10 for mean and standard deviation)
2	Variable name (information only)
3	C-index of variable

TABLE 74. INPUT DATA OPTIONS FOR INITIAL VALUES

	Unrestricted Inputs	Restricted Inputs					
		No Rail Dynamics		Rail Dynamics Included			
		Direct Fire		Direct Fire		Indirect Fire	
OPTN4	0	0	0	1	1	2	2
OPTN2	0	1	2	1	2	1	2
RXE	X	I	X	I	X	I	X
RYE	X	0	0	0	0	0	0
RZE	X	I	X	I	X	I	X
VXE	X	I	I	I	I	I	I
VYE	X	I	I	I	I	I	I
VZE	X	I	I	I	I	I	I
RTXE	X	0	0	0	0	0	0
RTYE	X	0	0	0	0	0	0
RTZE	X	0	0	0	0	0	0
BPSIO	X	I	I	X	X	X	X
BTHTO	X	I	I	X	X	X	X
BPHIO	X	0	0	0	0	0	0
BTHTG	X	X	X	I	I	X	X
BPSIG	X	X	X	I	I	X	X
RSLANT		X	I	X	I	X	I
BSLOV		X		X		X	
VWXE		X	X	X	X	X	X
VWYE	X	X	X	X	X	X	X
VWZE		X	X	X	X	X	X
(VMAHC VMWTE)*		X	X	X	X	X	X

X - denotes variables that must be specified by input data.
I - denotes variables that are computed internally.
0 - denotes variables that are either set to zero initially or will be computed as zero.

*Input VMACH if OPTN6 = 0; input VMWTE if OPTN6 = 1.

TABLE 75. WIND OPTION - OPTNW = 1

Fortran Symbol	C Index	Definition
BPSIW	51	Wind direction angle between wind velocity vector and negative X_E-axis (deg)
VWTE	52	Wind speed with respect to the earth (steady horizontal winds only) (ft/sec)

NOTE: If wind option OPTNW = 1 is input, the initial value of the components of the wind (VWXE, VWYE, VWZE) must be input also.

TABLE 76. THRUST MISALIGNMENT OPTION - QNALGN = 1

Fortran Symbol	C Index	Definition
BALPHT	1401	Thrust offset angle (α_T) measured from a line parallel to the X_B-axis and the thrust (deg)
BPHIT	1402	Thrust offset angle (Φ_T) measured from the plane parallel to the X_B-Z_B plane to the plane containing the thrust and the line parallel to the X_B-axis (deg)
RFXCG	1313	Thrust offset along X_B-axis (ft)
RFYCG	1314	Thrust offset along Y_B-axis (ft)
RFZCG	1315	Thrust offset along Z_B-axis (ft)

TABLE 77. ENGINE BURNOUT SWITCH - QBURN - 1

Fortran Symbol	C Index	Definition
WP	1739	Initial roll rate about X_B-axis (deg/sec)
WQ	1743	Initial pitch rate about Y_B-axis (deg/sec)
WR	1747	Initial yaw rate about Z_B-axis (deg/sec)
BALPHA	367	Initial vertical angle of attack (α, deg)
BALPHY	368	Initial sideslip sngle of attack (β, deg)
BPHIP	370	Initial aerodynamic roll angle (Φ', deg)

TABLE 78. TARGET MOTION OTTION - OPTARG = 1

Fortran Symbol	C Index	Definition
ATHRST	1629	Magnitude of the target acceleration vector (g)
ATURNT	1630	Scaling factor for the angular rotation rate of the target radius vector (g)
BGAMT	1631	Elevation angle of target, measured from the horizontal plane to the target position vector (deg)

TABLE 79. MONTE CARLO INPUTS

Fortran Symbol	C Index	Definition
RNSTRT	3511	Random number generator starting value. The nearest odd integer greater than or equal to RSSTRT will be used. (Changing RNSTRT will cause a different random number sequence to be used
SIGSPOT	1581	Expected standard deviation of spot jitter output (ft)
SIGU	54	Expected standard deviation of the wind gust output (based on wind direction and missile direction being colinear)
QNALGN	1403	Engine misalignment switch. Set to 1 to compute misalignment component value if a thrust misalignment 8 card is input
VWTE	52	(See Table 2.8 for VWTE input when a wind gusts 8 card is input)

B. Output

1. Introduction

The program provides several print and plot outputs. Some of the print outputs occur automatically. The remaining print outputs and the plot outputs are user options. A brief discussion and an example of each output is included in the paragraphs which follow.

2. Automatic Printouts

a. Input Conditions

The input data cards for each data set are printed out in card format at the end of the input phase for each case. An example is shown in Table 80.

b. Monte Carlo Initial Conditions

The Monte Carlo initial conditons are given in the listing which follows.

MONTE CARLO INITIAL CONDITIONS

C-INDEX	MC-VALUE	MEAN	DISTRIBUTION	LOWER BOUND	UPPER BOUND
52	-4.861	0.000	NORMAL	-3.000	3.000
51	54.903	0.000	UNIFORM	0.000	360.000
1247	.339	0.000	UNIFORM	-1.000	1.000
1248	.438	0.000	UNIFORM	-1.000	1.000
1249	-.091	0.000	UNIFORM	-1.000	1.000
1250	-.254	0.000	UNIFORM	-1.000	1.000

The headings are defined as follows:

1) C Index - Subscript number locating the Monte Carlo.

2) MC Value - Random number returned by MCARLO based on user input distribution.

3) Mean - User specified mean value about which MAARLO returne the MC-VALUE.

4) Distribution - User input distribution (NORMAL or UNIFORM).

5) Lower Bound - User input lower bound of the distribution from which MC-VALUE is selected.

6) Upper Bound - User input upper bound of the distribution from which MC-VALUE is selected.

c. Time and Step Size

Simulation time and integration step size are printed before and after the missile exits the launcher rail.

TIME = 0.0020000 STEP SIZE = 2.0000000E-03

d. Front Lug Clears Rail

When the front lug clears the rail, a pitch down moment is present on the missile. Because of the potential significance of this transient, a printout occurs at this point, giving the time that the front lug clears the rail, the velocity of the missile

TABLE 80. PRINTOUT OF INPUT DATA EXAMPLE

```
INPUT DATA

 1     OU T 2,3          3-0  -0. 0 -0.                     -0.                -0.0000   -0-0.0000
 1     STGL 2,3          4-0  -0. 0 -0.                     -0.                -0.0000   -0-0.0000
 2     G2-T             23-0  -0. 0 -0.                     -0.                -0.0000   -0-0.0000
 2 G3-H                 24-0  -0. 0 -0.                     -0.                -0.0000   -0-0.0000
 2 SPOT                 38-0  -0. 0 -0.                     -0.                -0.0000   -0-0.0000
 2 G5-H                 26-0  -0. 0 -0.                     -0.                -0.0000   -0-0.0000
 2     A1-T              2-0  -0. 0 -0.                     -0.                -0.0000   -0-0.0000
 2     A3-T              4-0  -0. 0 -0.                     -0.                -0.0000   -0-0.0000
 2 A2-H                  3-0  -0. 0 -0.                     -0.                -0.0000   -0-0.0000
 2 J1-H                 17-0  -0. 0 -0.                     -0.                -0.0000   -0-0.0000
 2 J2-H                 18-0  -0. 0 -0.                     -0.                -0.0000   -0-0.0000
 2          S4          31-0  -0. 0 -0.                     -0.                -0.0000   -0-0.0000
 2     C1-T              7-0  -0. 0 -0.                     -0.                -0.0000   -0-0.0000
 2     C4-T             10-0  -0. 0 -0.                     -0.                -0.0000   -0-0.0000
 3 T                 2. 0-0  -0. 0  0.                         .1000000E+01    -0.0000   -0-0.0000
 3  OPTNW               50-0  -0. 0  0.                     -0.                -0.0000   -0-0.0000
 3 VWTF                 52-0  -0. 0  0.                        .1000000E+01    -0.0000   -0-0.0000
 3 TF                2. 1-0   -0. 0    .1400000E+02 -0.                        -0.0000   -0-0.0000
 3 CPP               2 15-0   -0. 0    .1000000E+00 -0.                        -0.0000   -0-0.0000

 8 SPOT JITTER - Z   1681 3  -0. 0    .1000000E+01  -.3000000E+01     3.0000   -0  .0100
 8 SPOT JITTER - Y   1680 2  -0. 0    .1000000E+01  -.3000000E+01     3.0000   -0  .0100
 3 AKOAQ              837-0  -0. 0  0.                  -0.                -0.0000   -0-0.0000
 3 AKOAR              838-0  -0. 0  0.                  -0.                -0.0000   -0-0.0000
 8 AKOAQ              837-0  -0. 0    .3000000E-04  -.3000000E+01     3.0000   -0-0.0000
 8 AKOAR              838-0  -0. 0    .3000000E-04  -.3000000E+01     3.0000   -0-0.0000
 3 XE                1615-0  -0. 0   -.6560000E+04   .1000000E+01    -0.0000   -0-0.0000
 10 APP. ANGLE        571-0  -0. 0 -0.                  -0.                -0.0000   -0-0.0000
 10 BALPHA            387-0  -0. 0 -0.                  -0.                -0.0000   -0-0.0000
 10 BALPHY            388-0  -0. 0 -0.                  -0.                -0.0000   -0-0.0000
```

relative to the wind (airspeed), the pitch moment, and the magnitude of the separation distance from the rear of the launcher rail to the back of the rear lug. Also printed are the tipoff rates.

```
FRONT LUG CLEARS RAIL

  T =  1.12E-01      REL VEL =  6.57E+01     PITCH MOMENT = -1.20E+02
   RANGO  = 3.5352
                      TIPOFF RATES--ROLL =       0.0 PITCH =  -15.5 YAW =   -.5
```

e. Rear Lug Clears Rail

A printout, occurring at the time the rear lug clears the rail contains the time, the velocity of the missile relative to the wind (airspeed), and the rail lug force.

```
REAR LUG CLEARS RAIL    T =    .1460REL VEL =   85.656   RAIL FORCE =   -55.20
                     RANGO  = 6.1082
```

f. Engine Burnout Time

BURNOUT TIME = 3.7532 SEC

g. Maximum Breaklock Value

When using the optional optical contrast seeker, maximum values for breaklock (loss of target image) pitch and yaw are printed. If this seeker is not used, zero is printed for both values.

```
+++MAX BREAKLOCK VALUE =   0.00000 IN  PITCH

+++MAX BREAKLOCK VALUE =   0.00000 IN  YAW
```

h. Run Number

A count of the current total number of Monte Carlo runs.

RUN NUMBER = 26

i. Monte Carlo Time Series

A list of Monte Carlo time series variables and their values follows each Monte Carlo run.

MONTE CARLO TIME SERIES VALUES

C-INDEX	MEAN	VARIANCE	STD DEV	RMS
1681	-.069	.581	.762	.765
1680	.096	.637	.798	.804

1) C Index - Subscript number locating the Monte Carlo variable in the C-array.
2) Mean - Calculated mean value of the time series output.
3) Variance - Variance of the time series output.
4) Standard Deviation - Standard deviation (σ) of the time series output.
5) RMS - Root mean square of the time series output.

j. Spot Jitter Values

Values for the maximum and minimum deviations for the Y and Z components of laser designator spot motion are listed. Also, sample spot jitter Y and Z component mean, mean square, and radial RMS are printed.

```
MAX SPOT Y =   1.52 MIN SPOT Y =  -1.01
MAX SPOT Z =   1.19 MIN SPOT Z =  -1.36

SAMPLE SPOT JITTER Y-MEAN=   .09585    MEAN SQUARE=   .80369

SAMPLE SPOT JITTER Z-MEAN=  -.06893    MEAN SQUARE=   .76510    SPOT RADIAL RMS =   1.10964
```

k. End Conditions

The three programmed simulation terminations are: (1) ground impacted with missile to target range greater than 500 ft; (2) input value of maximum flight time exceeded; and (3) target plane intercepted. When simulation termination occurs due to conditions (1) and (2), no special end condition printouts are generated. When simulation termination is due to target plane intercept, the program prints the following information:

1) Miss distance (measured in the intercept plane).
2) Flight time at intercept.
3) Components of line-of-sight vector at intercept.
4) Y and Z components of miss distance (in the intercept plane).
5) Values of variables requested on print control type 4 cards.

A sample printout is shown below:

```
MISS DISTANCE =   1.6816804E+00
FLIGHT  TIME  =   3.2203602E+00
      RDELX =  -8.5689802E-02        RDELY =  -6.2013629E-01        RDELZ =   1.5602482E+00
                                     RYFP  =  -6.2182298E-01        RZFP  =   1.5624933E+00
```

3. Optional Printouts

Periodic printouts of variables requested by input (on type 4 cards) occur every CPP seconds, where CPP is an input parameter (Table 80). The variable names input on type 4 cards appear only once, followed by the instantaneous values of the variables. Subsequent interval printouts include only the variable values. A sample is shown in Table 81.

The values of every location in the C-array will be printed for every integration step, for a maximum of (6 DOC) integration steps, where DOC is an input variable. The printouts are unlabeled, containing only the C-array values. Because the printout includes only numerical values, no sample is shown. Mean and standard deviation of selected variables (selected by input on type 10 cards) are printed following terminal conditions printout. A sample follows:

MEAN VARIANCE AND STANDARD DEVIATION

C-LOCATION	MEAN	STD DEV
571	0.	0.
367	.49103190E+01	.34452543E+01
368	-.18781514E+00	.47258503E+01
357	.12699471E+00	.99612294E+00
358	-.31098433E+01	.62224015E+00
369	.71072849E+01	.26119775E+01

If CEP calculations are requested by input (type 9 card), several groups of optional printout will occur. A table of miss distances and Y and Z components of miss distance is printed first (Table 82). The CEPAS parameter control input data is listed in Table 83.

4. Plots

Example plot outputs resulting from the 7-cards shown in Table 81 are shown in Figures 65 through 67. Figures 65 and 66 are automatic time history plots, while Figure 67 is a paired plot for the two time history plots. If CEP information is computed, then plots of the CEP circle, the confidence circle, and the input miss distance points are generated (Figure 68). These plots are done on the computer printer and not on peripheral plotter.

TABLE 81. EXAMPLE TIME HISTORY PRINTOUT

INPUT DATA

1	OUPT 2,3	3-0	-0.00	-0.		-0.		-0.0000	-0-0.0000
1	STGE 2,3	4-0	-0.00	-0.		-0.		-0.0000	-0-0.0000
2	G2-T	23-0	-0.00	-0.		-0.		-0.0000	-0-0.0000
2	33-H	24-0	-0.00	-0.		-0.		-0.0000	-0-0.0000
2	SPOT	38-0	-0.00	-0.		-0.		-0.0000	-0-0.0000
2	35-H	26-0	-0.00	-0.		-0.		-0.0000	-0-0.0000
2	A1-T	2-0	-0.00	-0.		-0.		-0.0000	-0-0.0000
2	A3-T	4-0	-0.00	-0.		-0.		-0.0000	-0-0.0000
2	12-H	3-0	-0.00	-0.		-0.		-0.0000	-0-0.0000
2	J1-H	17-0	-0.00	-0.		-0.		-0.0000	-0-0.0000
2	J2-H	18-0	-0.00	-0.		-0.		-0.0000	-0-0.0000
2	S1	28-0	-0.00	-0.		-0.		-0.0000	-0-0.0000
2	C1-T	7-0	-0.00	-0.		-0.		-0.0000	-0-0.0000
2	C4-T	10-0	-0.00	-0.		-0.		-0.0000	-0-0.0000
3	T	2.00-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	OPTNH	50-0	-0.00	0.		-0.		-0.0000	-0-0.0000
3	VHTF	52-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	TF	2001-0	-0.00	.	00E+02	-0.		-0.0000	-0-0.0000
3	SPP	2015-0	-0.00	.	00E+0.	-0.		-0.0000	-0-0.0000
3	DOC	2013-0	-0.00	.	00E+01	-0.		-0.0000	-0-0.0000
3	DER(1)	2064-0	-0.00	.	00E-02		.1000000E+01	-0.0000	-0-0.0000
3	OPTN2	3502-0	-0.00	.	00E+01	-0.		-0.0000	-0-0.0000
3	OPTN4	3504-0	-0.00	.	00E+01	-0.		-0.0000	-0-0.0000
3	OPTN6	3506-0	-0.00	.	00E+01	-0.		-0.0000	-0-0.0000
3	VMACH	204-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	THETA LOS-V	363-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	PSI LOS-V	364-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	3ALPHA	362-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	3ALPHY	368-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	DT	446-0	-0.00	.	00E-01	-0.		-0.0000	-0-0.0000
3	CFOVZ	448-0	-0.00	.	00E+02	-0.		-0.0000	-0-0.0000
3	CFOVY	449-0	-0.00	.	00E+02	-0.		-0.0000	-0-0.0000
3	4LIMO	850-0	-0.00	.	00E+02	-0.		-0.0000	-0-0.0000
3	4LIME	851-0	-0.00	.	00E+02	-0.		-0.0000	-0-0.0000
3	4LIMP	865-0	-0.00	.	00E+01	-0.		-0.0000	-0-0.0000
3	3BIAS	852-0	-0.00	0.		-0.		-0.0000	-0-0.0000
3	R3IAS	853-0	-0.00	0.		-0.		-0.0000	-0-0.0000
3	33IAS	854-0	-0.00	.	00E+01		.1000000E+01	-0.0000	-0-0.0000
3	4P1	861-0	-0.00	.	00E+03	-0.		-0.0000	-0-0.0000
3	JP1	862-0	-0.00	.	00E+0.	-0.		-0.0000	-0-0.0000
3	TOY2	866-0	-0.00	0.		-0.		-0.0000	-0-0.0000
3	4Q1	871-0	-0.00	.	00E+03	-0.		-0.0000	-0-0.0000
3	JQ1	872-0	-0.00	.	00E+0.	-0.		-0.0000	-0-0.0000
3	TAUL	877-0	-0.00	.	00E+01	-0.		-0.0000	-0-0.0000
3	TAUZ	863-0	-0.00	.	00E+02	-0.		-0.0000	-0-0.0000
3	TAUY	864-0	-0.00	.	00E+02	-0.		-0.0000	-0-0.0000
3	3Z	867-0	-0.00	.	00E+01	-0.		-0.0000	-0-0.0000
3	3Y	855-0	-0.00	.	00E+01	-0.		-0.0000	-0-0.0000
3	DELTPB	1140-0	-0.00	0.		-0.		-0.0000	-0-0.0000
3	DELTQB	1141-0	-0.00	0.		-0.		-0.0000	-0-0.0000
3	DELTRB	1142-0	-0.00	0.		-0.		-0.0000	-0-0.0000
3	4DELTL	1143-0	-0.00	.	00E+03	-0.		-0.0000	-0-0.0000
3	3DELT	1144-0	-0.00	.	00E+02	-0.		-0.0000	-0-0.0000
3	3DP	1231-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	3DQ	1232-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	3DR	1233-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	3XERR	1260-0	-0.00	0		-0.		-0.0000	-0-0.0000
3	3ZERR	1261-0	-0.00	0		-0.		-0.0000	-0-0.0000
3	3YERR	1262-0	-0.00	0		-0.		-0.0000	-0-0.0000
3	3LERR	1263-0	-0.00	0		-0.		-0.0000	-0-0.0000
3	3MERR	1264-0	-0.00	0		-0.		-0.0000	-0-0.0000
3	3NERR	1265-0	-0.00	0		-0.		-0.0000	-0-0.0000
3	RFAREA	1306-0	-0.00		00E+0.	-0.		-0.0000	-0-0.0000
3	RFLGTH	1307-0	-0.00		00E+0.	-0.		-0.0000	-0-0.0000
3	RFXCG	1313-0	-0.00		00E+01	-0.		-0.0000	-0-0.0000
3	RFYCG	1314-0	-0.00	0		-0.		-0.0000	-0-0.0000
3	RFZCG	1315-0	-0.00	0		-0.		-0.0000	-0-0.0000
3	RLUG	1316-0	-0.00		00E+01	-0.		-0.0000	-0-0.0000
3	RAIL	1317-0	-0. 0		00E+01	-0.		-0.0000	-0-0.0000
3	3NALGN	1403-0	-0.00	0		-0.		-0.0000	-0-0.0000
3	PCFTH	1404-0	-0.00	0		-0.		-0.0000	-0-0.0000
3	3BURN	1405-0	-0.00	0			.1000000E+01	-0.0000	-0-0.0000
3	3ISP	1414-0	-0.00		00E+03	-0.		-0.0000	-0-0.0000
3	JWT	1415-0	-0.00		00E+03	-0.		-0.0000	-0-0.0000
3	JWP	1416-0	-0.00		000E+02	-0.		-0.0000	-0-0.0000
3	RDCGF	1418-0	-0.00	-	00E+0.	-0.		-0.0000	-0-0.0000
3	RDCGO	1417-0	-0.00	-	00E+0.	-0.		-0.0000	-0-0.0000
3	FMIXO	1419-0	-0.00		00E+0.	-0.		-0.0000	-0-0.0000
3	FMIYO	1420-0	-0.00		000E+02	-0.		-0.0000	-0-0.0000

TABLE 81. (Continued)

3	RLCGO	1421-0	-0.00	.	00E+01	-0.		-0.0000	-0-0.0000
3	VXE	1603-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	VYE	1607-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	VZE	1611-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	XE	1615-0	-0.00	-.	00E+0+		.1000000E+01	-0.0000	-0-0.0000
3	YE	1619-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	ZE	1623-0	-0.00	-.	00E+02		.1000000E+01	-0.0000	-0-0.0000
3	AGRAV	1627-0	-0.00	.	00E+02	-0.		-0.0000	-0-0.0000
3	OPTARG	1639-0	-0.00	0.		-0.		-0.0000	-0-0.0000
3	ODIVE	1606-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	P	1739-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	Q	1743-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	R	1747-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	CRAD	1751-0	-0.00	.	78E+02	-0.		-0.0000	-0-0.0000
3	OPHIO	1752-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	OTHTO	1753-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	OPSIO	1754-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	OPSIO	1754-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	STEP	2010-0	-0.00	.	00E+01	-0.		-0.0000	-0-0.0000
3	QPP	2015-0	-0.00	.	00E+0.		.1000000E+01	-0.0000	-0-0.0000
3	OER1	2664-0	-0.00	.	00E-01		.1000000E+01	-0.0000	-0-0.0000
3	XE	1615-0	-0.00	-.	00E+04		.1000000E+01	-0.0000	-0-0.0000
3	RLOCK	445-0	-0.00	.	00E+05	-0.		-0.0000	-0-0.0000
3	DT	446-0	-0.00	.	00E-01	-0.		-0.0000	-0-0.0000
3	ODB	447-0	-0.00	0.		-0.		-0.0000	-0-0.0000
3	CFOVZ	448-0	-0.00	.	00E+02	-0.		-0.0000	-0-0.0000
3	CFOVY	449-0	-0.00	.	00E+02	-0.		-0.0000	-0-0.0000
3	SSX	450-0	-0.00	.	00E+02	-0.		-0.0000	-0-0.0000
3	SEPS	451-0	-0.00	0.		-0.		-0.0000	-0-0.0000
3	SWP	452-0	-0.00	0.		-0.		-0.0000	-0-0.0000
3	RBK	453-0	-0.00	0.		-0.		-0.0000	-0-0.0000
3	SEO	454-0	-0.00	.	00E+02	-0.		-0.0000	-0-0.0000
3	OPTNSK	455-0	-0.00	0.		-0.		-0.0000	-0-0.0000
3	SS	456-0	-0.00	.	00E+01	-0.		-0.0000	-0-0.0000
3	4SL	457-0	-0.00	.	00E+02	-0.		-0.0000	-0-0.0000
3	4SN	458-0	-0.00	.	00E+02	-0.		-0.0000	-0-0.0000
3	4L2	459-0	-0.00	.	00E+02	-0.		-0.0000	-0-0.0000
3	4SL	457-0	-0.00	.	00E+01	-0.		-0.0000	-0-0.0000
3	4SL	457-0	-0.00	.	00E+02	-0.		-0.0000	-0-0.0000
3	ST	460-0	-0.00	0.			.1000000E+01	-0.0000	-0-0.0000
3	OER1	2664-0	-0.00	.	00E-01		.1000000E+01	-0.0000	-0-0.0000
3	XE	1615-0	-0.00	-.	00E+0+		.1000000E+01	-0.0000	-0-0.0000
4	BETA DEG	368-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	BPS	355-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	PDYNMC	203-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	ALPHA DEG	367-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4		1-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4		1-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4		1-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4		1-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	BTH	354-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	GAMMAH	357-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	RANGE	371-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	PHI MISSLE	352-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	R COM	823-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	BZ	12-0	-0.00	-0.		-0.		-0.0000	-0-0.0000
4	EPS Y	436-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	WLAMR	437-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	PSI GIMBAL	431-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	FTHRST	1411-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	FTHRST	1410-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	EPS Z	435-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	WLAMQ	403-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	THETA GIMBAL	427-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	BY	11-0	-0.00	-0.		-0.		-0.0000	-0-0.0000
4	Q COM	811-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	SPOT JITY	1683-0	-0.00	-0.		-0.		-0.0000	-0-0.0000
4	RDELY	1636-0	-0.00	-0.		-0.		-0.0000	-0-0.0000
4	BXX	880-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	AIR SPEED	207-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	YAW FLAP	1233-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	PITCH FLAP	1232-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	ROLL FLAP	1231-0	-0.00	0.		-0.		-0.0000	-0-0.0000
4	ALTITUDE	209-0	-0.00	-0.		-0.		-0.0000	-0-0.0000
3	XE	1615-0	-0.00	-.	0E+0+		.1000000E+01	-0.0000	-0-0.0000
3	ZE	1623-0	-0.00	-.	0E+03		.1000000E+01	-0.0000	-0-0.0000
7	RANGE	371-0	-0.00	-0.		-0.		-0.0000	-0-0.0000
7	ALTITUDE	209-0	-0.00	-0.		-0.		-0.0000	-0-0.0000
3	PPP	2005-0	-0.00	.	0E-01	-0.		-0.0000	-0-0.0000
3	PST	2002-0	-0.00	0.		-0.		-0.0000	-0-0.0000
3	PLOTN4	1962-0	-0.00	0.		-0.		-0.0000	-0-0.0000
3	PLOTN2	1983-0	-0.00	.	0E+01	-0.		-0.0000	-0-0.0000
6		-0-0	-0.00	-0.		-0.		-0.0000	-0-0.0000

TIME= .0020000 STEP SIZE= 000E-03

TABLE 81. (Continued)

TIME	BETA DEG	BPS	PDYNMC	ALPHA DEG	
				BTH	GAMMAH
	RANGE	PHI MISSLE	R COM	BZ	EPS Y
	WLAMR	PSI GIMBAL	FTHRST	FTHRST	EPS Z
	WLAMQ	THETA GIMBAL	BY	Q COM	SPOT JITY
	RDELY	BXX	AIR SPEED	YAW FLAP	PITCH FLAP
	ROLL FLAP	ALTITUDE			
.0020000	0.	0.	6.9089499E-06	0.	0.
	0.	0.	0.	0.	0.
	6.5600933E+03	0.	-1.1217513E-01	1.0000000E+03	-3.2529870E-03
	5.1000000E-01	3.2530333E-03	2.8590000E+02	2.8590000E+02	-3.2530362E-03
	5.1000000E-01	-3.0243801E-01	1.0000000E+00	-2.3928811E-02	0.
	0.	6.5309435E+00	7.6207409E-02	-2.0829375E-06	-1.7228392E-03
	-3.4694470E-18	3.5000000E+01			
.1000000	0.	0.	4.0666650E+00	0.	0.
	0.	0.	0.	0.	0.
	6.5573083E+03	0.	-5.0578985E-01	1.0000000E+00	3.2278827E-03
	5.0000000E-01	-3.2279287E-03	2.2000000E+03	2.2000000E+03	3.6980929E-03
	5.0000000E-01	-3.0891898E-01	1.0000000E+00	-1.0002353E+00	0.
	0.	-8.1253618E+01	5.8528318E+01	-5.7490656E-01	-8.9373930E-01
	-1.7763568E-15	3.5000000E+01			

FRONT LUG CLEARS RAIL T = 1.12E-01 REL VEL = 6.56E+01 PITCH MOMENT = -1.20E+02
RANGO = 3.5299

TIPOFF RATES--ROLL = 0.0 PITCH = -15.6 YAW = .0

REAR LUG CLEARS RAIL T = .1460REL VEL = 85.531 RAIL FORCE = -55.30
RANGO = 6.0991

TIME= .1500000 STEP SIZE= 1.2500000E-02

.2000000	-9.6200540E-03	0.	1.6309476E+01	2.6472564E-01	0.
	0.	0.	0.	0.	-2.5135145E-03
	6.5485209E+03	-1.4701422E-04	-7.1059677E+00	-1.0000000E+00	-9.1811891E-03
	-5.0000000E-01	2.0767625E-03	2.1659259E+03	2.1659259E+03	-8.8509778E-03
	-5.0000000E-01	7.8733268E-01	-1.0000000E+00	-1.5987612E+01	1.9498511E-04
	1.9498511E-04	-7.6682525E+01	1.1721640E+02	-8.6156608E-01	-5.1074979E+00
	6.6555588E-06	3.4900545E+01			
.3000000	-4.4836198E-02	0.	3.6752247E+01	2.9804319E-01	0.
	0.	0.	0.	0.	5.4924492E-03
	6.5338706E+03	-4.1014492E-03	-9.3714262E+00	-1.0000000E+00	-2.8085353E-02
	-5.0000000E-01	-2.2135342E-02	2.1403333E+03	2.1403333E+03	-2.3883665E-02
	-5.0000000E-01	2.0321364E+00	-1.0000000E+00	-1.0769658E+01	2.6432921E-04
	2.6432921E-04	8.9851397E+01	1.7594799E+02	2.4821423E-01	-7.5536664E+00
	9.5753521E-04	3.4378799E+01			

TABLE 81. (Concluded)

TIME	BETA DEG	BPS	PDYNMC	ALPHA DEG	
				BTH	GAMMAH
	RANGE	PHI MISSLE	R COM	BZ	EPS Y
	WLAMR	PSI GIMBAL	FTHRST	FTHRST	EPS Z
	WLAMQ	THETA GIMBAL	BY	Q COM	SPOT JITY
	RDELY	BXX	AIR SPEED	YAW FLAP	PITCH FLAP
	ROLL FLAP	ALTITUDE			
7.7000000	1.1110113E-01	0.	8.0793640E+02	1.2434822E+00	0.
	0.	0.	0.	0.	6.2890294E-02
	1.9466856E+02	4.0889947E-02	2.9745381E-01	1.0000000E+00	-5.7751414E-02
	-5.0000000E-01	7.6513364E-02	0.	0.	2.4876831E-02
	-1.7763568E-14	-1.3587456E+00	-1.0000000E+00	-8.9618514E-01	-1.0040791E-01
	-1.0040791E-01	-7.1291124E+01	8.2459320E+02	3.1098294E-01	-8.3695583E-01
	-2.5071586E-03	7.8785544E+00			
7.8000000	2.0411641E-01	0.	8.0295983E+02	1.2601038E+00	0.
	0.	0.	0.	0.	3.9798802E-02
	1.1233916E+02	1.3058831E-01	-1.2245936E+00	1.0000000E+00	1.6929502E-02
	-1.7763568E-14	5.9966074E-02	0.	0.	2.0836783E-02
	-1.7763568E-14	-1.3410099E+00	1.0000000E+00	-3.4541795E+00	-1.7165891E-01
	-1.7165891E-01	-7.1201750E+01	8.2200528E+02	5.6424813E-01	-8.5213405E-01
	-4.2034587E-02	4.6276991E+00			
7.9000000	6.1354528E-01	0.	7.9833680E+02	1.2752660E+00	0.
	0.	0.	0.	0.	-2.3718599E-02
	3.0267782E+01	2.9324974E-01	-1.7174043E+00	-1.0000000E+00	-2.3932380E-01
	-1.0000000E+00	4.9777946E-01	0.	0.	-1.4769283E-02
	-1.0000000E+00	-1.3229151E+00	-1.0000000E+00	-1.5623704E+00	-2.0024444E-01
	-2.0024444E-01	-7.1306211E+01	8.1943596E+02	2.1137649E-01	-8.6497808E-01
	-1.0639904E-01	1.2846528E+00			

***MAX BREAKLOCK VALUE = 0.00000 IN PITCH

***MAX BREAKLOCK VALUE = 0.00000 IN YAW

RUN NUMBER = 1

MISS DISTANCE = 1.8205676E-01

FLIGHT TIME = 7.9369581E+00

RDELX = -1.2198553E-03 RDELY = -1.8020441E-01 RDELZ = 2.5511378E-02

RYFP = -1.8025088E-01 RZFP = 2.5578962E-02

7.9375000	5.8775581E-01	0.	7.9620485E+02	1.3024813E+00	0.
	0.	0.	0.	0.	-4.8954043E-02
	4.7949219E-01	2.6198915E-01	-1.4921610E+00	-1.0000000E+00	-1.5775664E+02
	-1.1875000E+00	4.4490916E-01	0.	0.	-1.7652209E+02
	-1.1875000E+00	-1.3793183E+00	-1.0000000E+00	-1.9659238E+00	-1.7984852E-01
	-1.7984852E-01	-8.0820176E+01	8.1847750E+02	8.8751453E-01	-4.4461476E-01
	-8.0484428E-02	7.0000194E-03			

START PLOTTING AT 0.0000000
PLOTTING ENDED AT

TABLE 82. COMPILED MISS DISTANCE LIST

										Y-MISS		Z-MISS		MISS DIST	
1	1	1	1	1	1	1	1	1	1	-.35554	1	-2.48622	1	2.51152	1
1	1	1	1	1	1	1	1	1	1	.80615	1	-.03961	1	.81228	1
1	1	1	1	1	1	1	1	1	1	-2.14152	1	.40910	1	2.18025	1
1	1	1	1	1	1	1	1	1	1	-.11527	1	-1.30635	1	1.31143	1
1	1	1	1	1	1	1	1	1	1	-1.18125	1	-3.40467	1	3.60377	1
1	1	1	1	1	1	1	1	1	1	.85583	1	-1.37950	1	1.62341	1
1	1	1	1	1	1	1	1	1	1	2.42137	1	-1.57833	1	2.89036	1
1	1	1	1	1	1	1	1	1	1	1.49364	1	2.30898	1	2.74997	1
1	1	1	1	1	1	1	1	1	1	-.64028	1	-.76966	1	1.00116	1
1	1	1	1	1	1	1	1	1	1	.78404	1	-.21740	1	.81362	1
1	1	1	1	1	1	1	1	1	1	.13083	1	-1.31161	1	1.31812	1
1	1	1	1	1	1	1	1	1	1	-.38704	1	-1.93894	1	1.97719	1
1	1	1	1	1	1	1	1	1	1	.51765	1	-3.55487	1	3.59237	1
1	1	1	1	1	1	1	1	1	1	.82765	1	-.28518	1	.87543	1
1	1	1	1	1	1	1	1	1	1	.57034	1	-1.12686	1	1.26297	1
1	1	1	1	1	1	1	1	1	1	-2.14179	1	-.73669	1	2.26495	1
1	1	1	1	1	1	1	1	1	1	-1.50394	1	-1.36641	1	2.03197	1
1	1	1	1	1	1	1	1	1	1	-.01549	1	1.77516	1	1.77523	1
1	1	1	1	1	1	1	1	1	1	-.58725	1	-1.39819	1	1.51652	1
1	1	1	1	1	1	1	1	1	1	.28197	1	-3.25879	1	3.27096	1
1	1	1	1	1	1	1	1	1	1	2.72812	1	-1.71696	1	3.22345	1
1	1	1	1	1	1	1	1	1	1	.95137	1	-.71735	1	1.19150	1
1	1	1	1	1	1	1	1	1	1	1.30010	1	-1.93878	1	2.33434	1
1	1	1	1	1	1	1	1	1	1	.74890	1	-1.36456	1	1.55656	1
1	1	1	1	1	1	1	1	1	1	.00300	1	-3.03371	1	3.03371	1
1	1	1	1	1	1	1	1	1	1	-.88764	1	-1.10268	1	1.41509	1
1	1	1	1	1	1	1	1	1	1	1.07232	1	-.09239	1	1.07630	1

TABLE 83. EXAMPLE CEPAS STATISTICAL OUTPUT

```
CASE NO.=   1

            MEAN=      -.9331STD DEV=     1.9782
NSTEPS=       5  YMIN=-3.644 YMAX= 3.025
DMAX=  .4736000  CRITICAL VAL=  .2700000
CASE NO.=   2

            MEAN=       .5354STD DEV=     1.5547
NSTEPS=       5  YMIN=-3.590 YMAX= 4.724
DMAX=  .7110000  CRITICAL VAL=  .2700000
X-COMPONENT OF MISS-DISTANCE FAIL K-S TEST FOR NORMALITY AT       .05000  SIGNIFICANCE LEVEL

Y-COMPONENT OF MISS DISTANCE FAIL K-S TEST FOR NORMALITY AT       .05000  SIGNIFICANCE LEVEL

JOINT CEP=  2.067  FOR THE FOLLOWING   25 POINTS
              ( -.17,-2.59)      MISS DIST= 3.15
              ( 1.18, -.35)      MISS DIST= 1.93
              (  .77,-2.10)      MISS DIST= 2.95
              (-3.02, 4.72)      MISS DIST= 4.97
              ( -.03,  .05)      MISS DIST=  .79
              (-1.08, -.05)      MISS DIST=  .80
              ( 1.64, 1.44)      MISS DIST= 2.54
              (-1.13,  .98)      MISS DIST=  .75
              (  .40, 2.03)      MISS DIST= 1.76
              ( 1.50,  .08)      MISS DIST= 2.08
              (-3.03, 1.53)      MISS DIST= 3.69
              (-1.81, 1.31)      MISS DIST= 1.49
              (-2.81, -.03)      MISS DIST= 2.34
              (-3.15, -.17)      MISS DIST= 2.71
              ( 2.55, 2.26)      MISS DIST= 3.53
              (-3.64,  .33)      MISS DIST= 3.12
              ( -.24,  .77)      MISS DIST=  .81
              ( -.89, -.03)      MISS DIST=  .67
              (-2.38,  .49)      MISS DIST= 1.84
              (-1.31, -.87)      MISS DIST= 1.60
              ( 2.05, 2.26)      MISS DIST= 3.11
              (-2.14,-1.73)      MISS DIST= 2.78
              ( -.84,  .29)      MISS DIST=  .42
              ( 1.06,  .52)      MISS DIST= 1.59
              (-3.55, 2.26)      MISS DIST= 3.47

CONFIDENCE INTERVAL(S) FOR JOINT CEP

                                          (PER CENT)
CONFIDENCE LEVELS ----------  99
                           ------   ------   ------   ------   ------
                             2.78
                                              (FT)

MISSILE CEP=  1.461 ASSUMING  SIMULATION CEP=  1.00 TIMES THE MISSILE CEP

CONFIDENCE INTERVAL(S) FOR MISSILE CEP
                                          (PER CENT)
CONFIDENCE LEVELS ----------  99
```

Miss Distance Relative to CEP Center

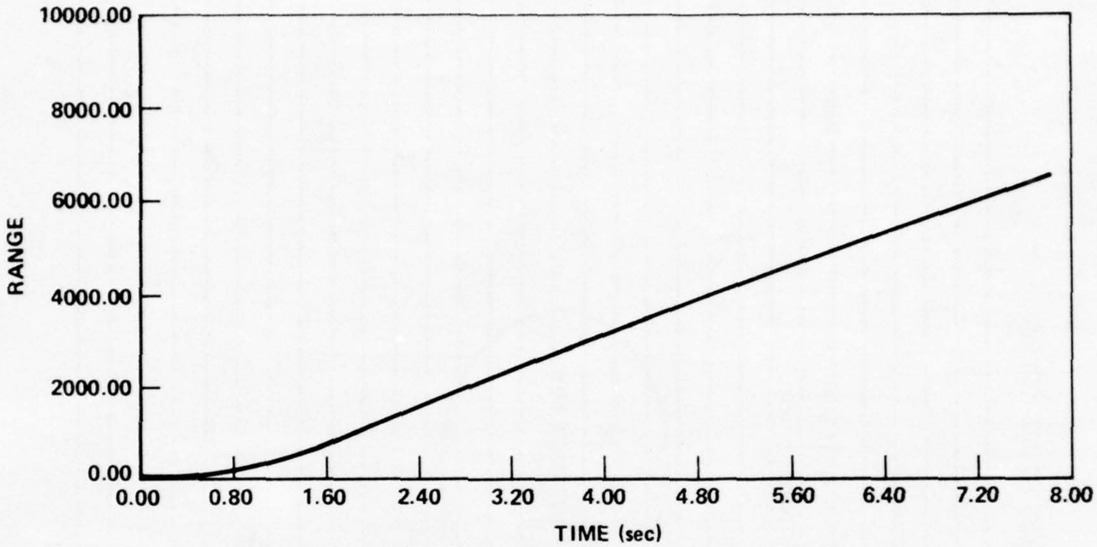

Figure 65. Range time history example plot.

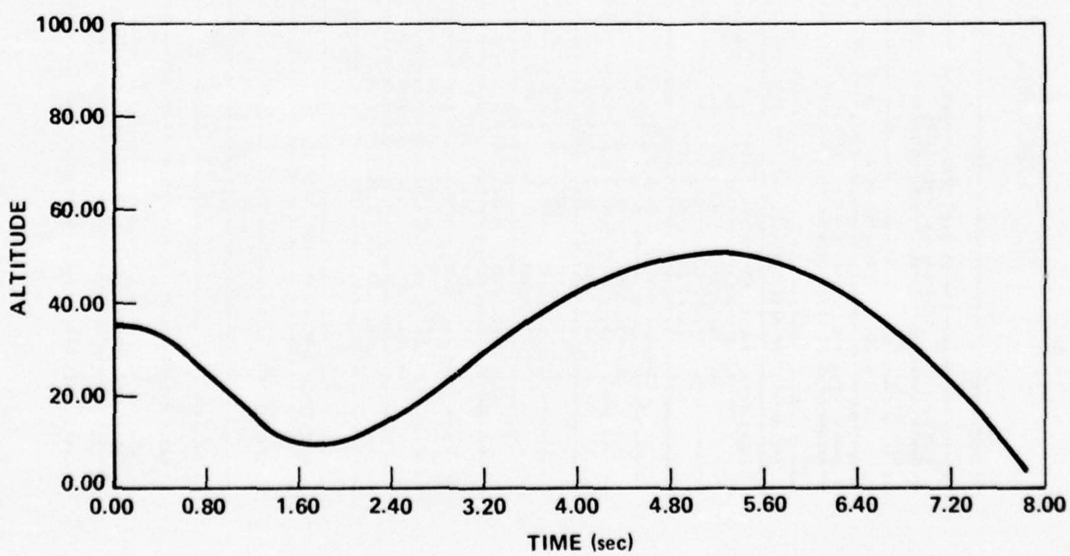

Figure 66. Altitude time history example plot.

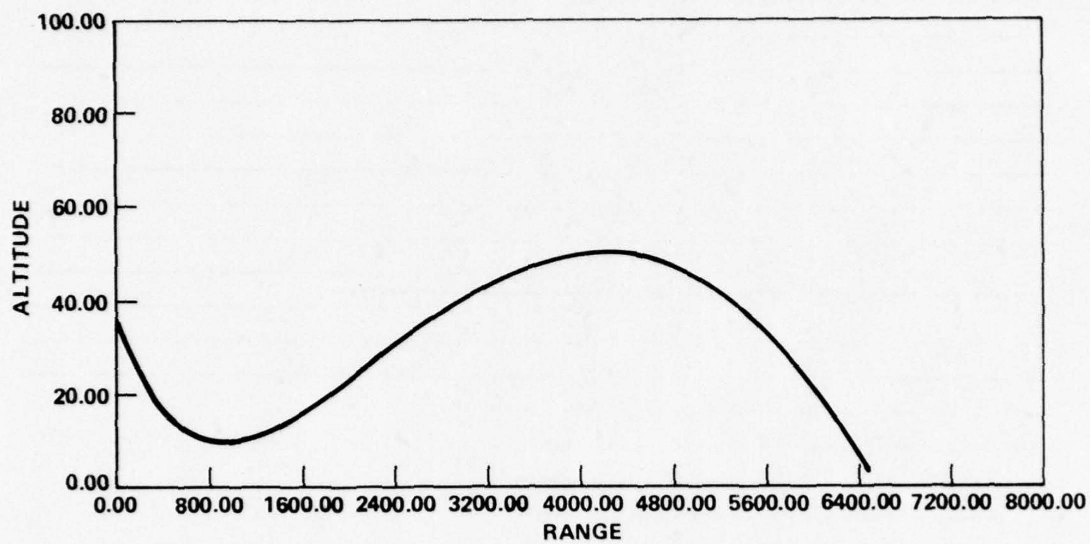

Figure 67. Altitude versus range example plot.

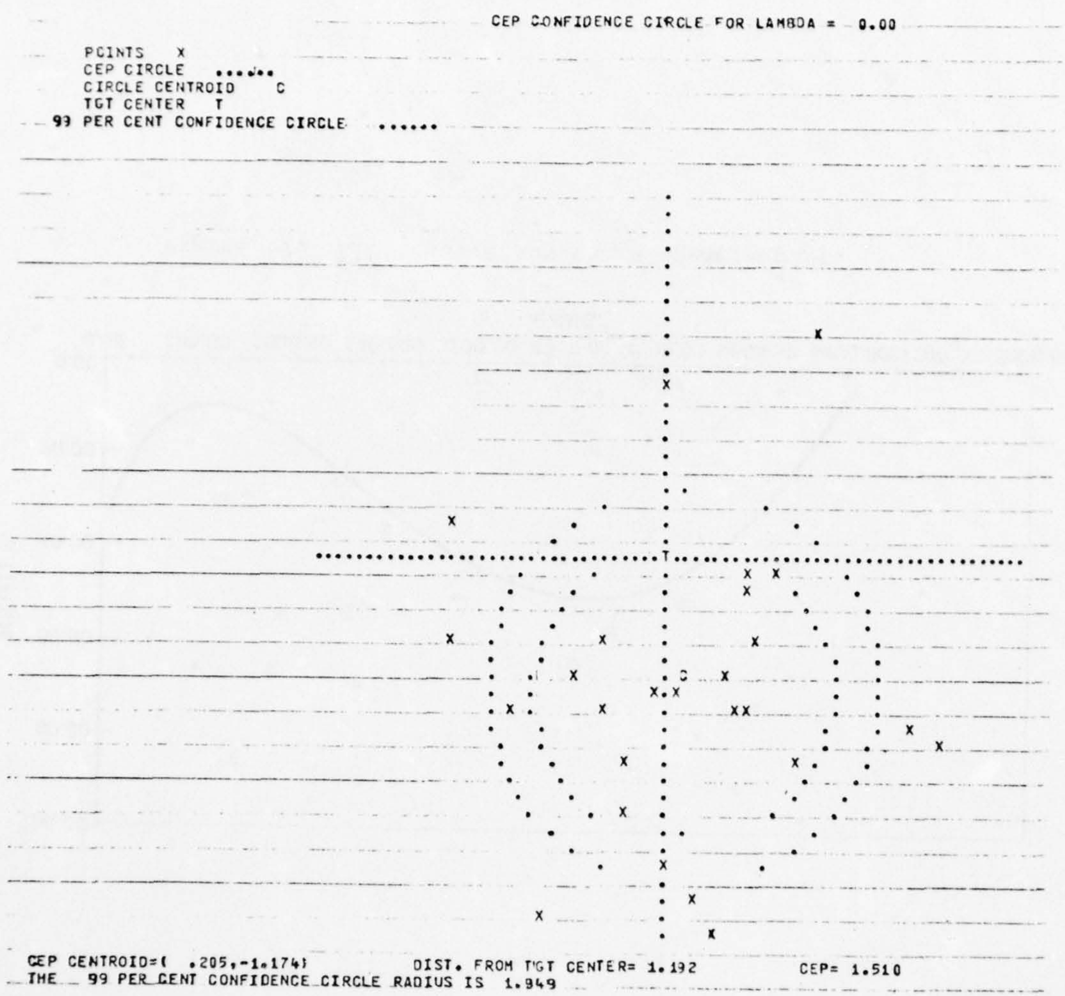

Figure 68. Plots of the CEP circle, the confidence circle, and the input miss distance points.

TABLE 84. CROSS REFERENCE OF C ARRAY

EQUIVALENCE (C(11),BY)	S1	13
EQUIVALENCE (C(11),BY)	S1	165
EQUIVALENCE (C(11),BY)	S4	44
EQUIVALENCE (C(11),BY), (C(12),BZ)	S4	287
EQUIVALENCE (C(12),BZ)	S1	14
EQUIVALENCE (C(12),BZ)	S1	166
EQUIVALENCE (C(12),BZ)	S4	45
EQUIVALENCE (C(11),BY), (C(12),BZ)	S4	287
C(13) = 1.	A2	106
C(13) = -1.	S1	73
IF(C(13).LE.0.) GO TO 820	S1	212
C(13) = -1.	S1	213
C(13) = -1.	S4	167
IF(C(13).LE.0.) GO TO 820	S4	359
C(13) = -1.	S4	360
C(13)=-1.	S2	186
IF(C(13).LE.0.)GO TO 1	S2	386
C(13)=-1.	S2	387
IF(C(13).LE.0.)GO TO 1	S3	114
C(13)=-1.	S3	115
EQUIVALENCE (C(17), RDSTOT)	S4	46
C(17) = 0.	S4	99
EQUIVALENCE (C(17),RDSTOT)	S4	254
C(18) = 0.	S4	100
EQUIVALFNCE(C(19),PSIZE)	MC7	30
EQUIVALENCE (C(19),PSIZE)	IO	21
EQUIVALENCE (C(21),IBVNSW)	MC7	20
EQUIVALENCE (C(21),IBVNSW)	IO	19
EQUIVALENCE (C(22), IPLOT)	MC7	21
EQUIVALENCE (C(22), IPLOT)	IO	20
EQUIVALENCE (C(23),XLAMBD)	MC7	22
EQUIVALENCE (C(23),XLAMBD)	IO	22
EQUIVALENCE (C(24), KSSIG)	MC7	23
EQUIVALENCE (C(24), KSSIG)	IO	23
EQUIVALENCE (C(25),CEPSIG)	MC7	24
EQUIVALENCE (C(25),CEPSIG)	IO	24

TABLE 84. (Continued)

```
EQUIVALENCE (C( 31),LCEP)                                          MC7       32
EQUIVALENCE (C( 31), LCEP)                                         G4        29
DIMENSION SVC(40),SVCT(40),IDISTT(7)                               MCARLO    41
EQUIVALENCE (C(  50),OPTNW )                                       G2        54
EQUIVALENCE (C(  51),BPSIW )                                       G2        55
EQUIVALENCE (C(  52),  VWTE)                                       G2         7
EQUIVALENCE (C(  52),VWTE  )                                       G2        56
EQUIVALENCE (C(  54),  SIGU)                                       G2         8
EQUIVALENCE (C(  54),  SIGU)                                       G2        62
EQUIVALENCE (C(  56),   BLU)                                       G2         9
EQUIVALENCE (C(  56),   BLU)                                       G2        63
EQUIVALENCE (C(  58), WNDWO)                                       G2        10
EQUIVALENCE (C(  58), WNDWO)                                       G2        64
EQUIVALENCE (C(  59),  SLWD)                                       G2        11
EQUIVALENCE (C(  59),  SLWD)                                       G2        65
EQUIVALENCE (C(  60),   RLW)                                       MCARLO     4
EQUIVALENCE (C(  60),   RLW)                                       G2        12
EQUIVALENCE (C(  60),   RLW)                                       G2        66
EQUIVALENCE (C(  62),   SLW)                                       G2        13
EQUIVALENCE (C(  62),   SLW)                                       G2        67
EQUIVALENCE (C(  65),CBPSIW)                                       G2        14
EQUIVALENCE (C(  65),CBPSIW)                                       G2        68
EQUIVALENCE (C(  66),SBPSIW)                                       G2        15
EQUIVALENCE (C(  66),SBPSIW)                                       G2        69
EQUIVALENCE (C(  68), VWTEM)                                       G2        70
EQUIVALENCE (C(  69), GSIGU)                                       G2        16
EQUIVALENCE (C(  69), GSIGU)                                       G2        71
EQUIVALENCE (C(  70), GVWTE)                                       G2        17
EQUIVALENCE (C( 100),  VWXE)                                       G2        18
EQUIVALENCE (C( 100),VWXE  )                                       G2        58
EQUIVALENCE (C(0100),VWXE  )                                       G3         8
EQUIVALENCE (C( 100),VWXE  )                                       D1        11
EQUIVALENCE (C( 101), VWYE)                                        G2        19
EQUIVALENCE (C( 101),VWYE  )                                       G2        59
```

TABLE 84. (Continued)

```
EQUIVALENCE (C(0101),VWYE  )                                      G3      9
EQUIVALENCE (C( 101),VWYE  )                                      D1     12
EQUIVALENCE (C( 102), VWZE)                                       G2     20
EQUIVALENCE (C( 102),VWZE  )                                      G2     60
EQUIVALENCE (C(0102),VWZE  )                                      G3     10
EQUIVALENCE (C( 102),VWZE  )                                      D1     13
EQUIVALENCE (C(0200),VMWXE )                                      G3     19
EQUIVALENCE (C(0200),VMWXE )                                      G5      7
EQUIVALENCE (C(0201),VMWYE )                                      G3     20
EQUIVALENCE (C(0201),VMWYE )                                      G5      8
EQUIVALENCE (C(0202),VMWZE )                                      G3     21
EQUIVALENCE (C(0202),VMWZE )                                      G5      9
EQUIVALENCE (C(0203),PDYNMC)                                      G3     22
EQUIVALENCE (C(0203),PDYNMC)                                      A2     21
EQUIVALENCE (C(0204),VMACH )                                      G3     23
EQUIVALENCE (C(0204),VMACH )                                      A1     12
EQUIVALENCE (C( 204),VMACH )                                      A2     22
EQUIVALENCE (C( 204),VMACH )                                      D1     14
EQUIVALENCE (C( 204),VMACH)                                       C5     79
WRITE (6,30) C(2000),C(367),C(368),C(204),C(369),C(370),C(1117),  EXEC  282
EQUIVALENCE (C(0205),DRHO  )                                      G3     24
EQUIVALENCE (C(0206),VSOUND)                                      G3     25
EQUIVALENCE (C(0207),VAIRSP)                                      G3     26
EQUIVALENCE (C(0207),VAIRSP)                                      G5     10
EQUIVALENCE (C(0207),VAIRSP)                                      A2     23
EQUIVALENCE (C( 207),VMWTE )                                      S4     52
EQUIVALENCE (C(0208),RHZRO )                                      G3      6
EQUIVALENCE (C(0209),RH    )                                      G3     27
C( 209)=-RZE                                                      S4    118
EQUIVALENCE (C( 209),RH    )                                      S4    249
EQUIVALENCE (C(300),RMISS)                                        MC7    25
EQUIVALENCE (C( 300),RMISS )                                      G4     25
EQUIVALENCE (C(301),      L)                                      MC7    28
$,           (C(301),L     )                                      G4     26
EQUIVALENCE (C(302),  RYF)                                        MC7    29
*,           (C( 302),RYF   )                                     G4     27
EQUIVALENCE (C(303),  RZF)                                        MC7    31
*,           (C( 303),RZF   )                                     G4     28
EQUIVALENCE (C(0350),BTHT  )                                      G5     83
EQUIVALENCE (C( 350),BTHT  )                                      A2     24
EQUIVALENCE (C(0351),BPSI  )                                      G5     84
EQUIVALENCE (C(0352),BPHI  )                                      G5     85
EQUIVALENCE (C( 353),BPH1  )                                      G5     86
EQUIVALENCE (C(353),BPH1)                                         C1     94
EQUIVALENCE (C( 353),BPH1)                                        C3     39
EQUIVALENCE (C( 354),BTH2  )                                      G5     87
```

TABLE 84. (Continued)

EQUIVALENCE (C(354),BTH2)	C3	40
EQUIVALENCE (C(355),BPS1)	G5	88
EQUIVALENCE (C(355),BPS1)	C3	41
EQUIVALENCE (C(0356),VTOTE)	G5	89
EQUIVALENCE (C(0357),BGAMH)	G5	90
EQUIVALENCE (C(357),BGAMH)	G4	13
EQUIVALENCE (C(0358),BGAMV)	G5	91
*, (C(358),BGAMV)	G4	14
EQUIVALENCE (C(360),BPH1ER)	D1	73
EQUIVALENCE (C(361),BTH2ER)	D1	74
EQUIVALENCE (C(362),BPS1ER)	D1	75
EQUIVALENCE (C(0363),BTHLV)	G5	92
C(363) = 0.	D1	126
EQUIVALENCE (C(0364),BPSLV)	G5	93
C(364) = 0.	D1	127
EQUIVALENCE (C(0365),BLAMV)	G5	94
EQUIVALENCE (C(0366),BLAMH)	G5	95
EQUIVALENCE (C(0367),BALPHA)	G5	96
EQUIVALENCE (C(0367),BALPHA)	A1	13
EQUIVALENCE (C(367),BALPHA)	A3	7
EQUIVALENCE (C(367),BALPHA)	D1	15
WRITE (6,30) C(2000),C(367),C(368),C(204),C(369),C(370),C(1117),	EXEC	282
EQUIVALENCE (C(0368),BALPHY)	G5	97
EQUIVALENCE (C(0368),BALPHY)	A1	14
EQUIVALENCE (C(368),BALPHY)	A3	8
EQUIVALENCE (C(368),BALPHY)	D1	16
WRITE (6,30) C(2000),C(367),C(368),C(204),C(369),C(370),C(1117),	EXEC	282
EQUIVALENCE (C(0369),BALPHP)	G5	98
EQUIVALENCE(C(369),BALPHP)	A1	15
WRITE (6,30) C(2000),C(367),C(368),C(204),C(369),C(370),C(1117),	EXEC	282
EQUIVALENCE (C(0370),BPHIP)	G5	99
EQUIVALENCE (C(0370),BPHIP)	A1	16
EQUIVALENCE (C(370),BPHIP)	A3	9
WRITE (6,30) C(2000),C(367),C(368),C(204),C(369),C(370),C(1117),	EXEC	282
EQUIVALENCE (C(0371),RANGE)	G5	100
EQUIVALENCE (C(371),RANGE)	D1	320
EQUIVALENCE (C(0371),RANGE)	S1	142
EQUIVALENCE (C(371),RANGE),(C(1615),RXE),(C(1623),RZE)	S4	76
EQUIVALENCE (C(0371),RANGE)	S4	242
*, (C(371),RANGE)	G4	15
EQUIVALENCE (C(371), RANGE)	S2	57
EQUIVALENCE (C(371), RANGE)	S2	330
EQUIVALENCE (C(371), RANGE)	S3	64
EQUIVALENCE (C(0372),RXBA)	G5	101
EQUIVALENCE (C(0372),RXBA)	S1	143
EQUIVALENCE (C(0372),RXBA)	S4	243

TABLE 84. (Continued)

```
EQUIVALENCE (C( 372),   RXBA)                                    S2    322
EQUIVALENCE (C( 372),   RXBA)                                    S3     56
EQUIVALENCE (C(0373),RYBA  )                                     G5    102
EQUIVALENCE (C(0373),RYBA  )                                     S1    144
EQUIVALENCE (C(0373),RYBA  )                                     S4    244
EQUIVALENCE (C( 373),   RYBA)                                    S2    323
EQUIVALENCE (C( 373),   RYBA)                                    S3     57
EQUIVALENCE (C(0374),RZBA  )                                     G5    103
EQUIVALENCE (C(0374),RZBA  )                                     S1    145
EQUIVALENCE (C(0374),RZBA  )                                     S4    245
EQUIVALENCE (C( 374),   RZBA)                                    S2    324
EQUIVALENCE (C( 374),   RZBA)                                    S3     58
EQUIVALENCE (C( 380),RANGO )                                     G5    104
EQUIVALENCE (C( 380),RANGO )                                     A2     25
EQUIVALENCE (C( 390),RXL   )                                     G5    105
EQUIVALENCE (C( 391),RYL   )                                     G5    106
EQUIVALENCE (C( 392),RZL   )                                     G5    107
EQUIVALENCE (C( 393),BPH2  )                                     G5    108
EQUIVALENCE (C(0403),WLAMQ )                                     S1    167
EQUIVALENCE (C( 403),WLAMZ )                                     S4    288
EQUIVALENCE (C(0403),EZ    )                                     C1    106
EQUIVALENCE (C(403),WLAMQ)                                       C3     37
C(403)=0.      $ C(407)=0.      $ C(424)=0.      $ C(428)=0.     S2    198
EQUIVALENCE (C( 403),   WLAMQ)                                   S2    364
EQUIVALENCE (C( 403),   WLAMQ)                                   S3     92
EQUIVALENCE (C(0407),WLAMR )                                     S1    168
EQUIVALENCE (C( 407),WLAMY )                                     S4    289
EQUIVALENCE (C(0407),EY    )                                     C1    107
EQUIVALENCE (C(407),WLAMR)                                       C3     38
C(403)=0.      $ C(407)=0.      $ C(424)=0.      $ C(428)=0.     S2    198
EQUIVALENCE (C( 407),   WLAMR)                                   S2    365
EQUIVALENCE (C( 407),   WLAMR)                                   S3     93
EQUIVALENCE (C(0408),WLQD  )                                     S1    151
EQUIVALENCE (C(0408),WLQD  )                                     S4    257
EQUIVALENCE(C(0411),WLQ)                                         S1     20
C(411)=0.                                                        S1     37
EQUIVALENCE (C(0411),WLQ   )                                     S1    152
EQUIVALENCE(C(0411),WLQ)                                         S4     53
C(411)=0.                                                        S4    108
EQUIVALENCE (C(0411),WLQ   )                                     S4    258
EQUIVALENCE (C(0412),WLRD  )                                     S1    153
EQUIVALENCE (C(0412),WLRD  )                                     S4    259
EQUIVALENCE(C(0415),WLR)                                         S1     21
C(415)=0.                                                        S1     38
EQUIVALENCE (C(0415),WLR   )                                     S1    154
EQUIVALENCE(C(0415),WLR)                                         S4     54
```

TABLE 84. (Continued)

```
C(415)=0.                                                          S4    109
EQUIVALENCE (C(0415),WLR   )                                       S4    260
EQUIVALENCE (C(0416),WLQSD )                                       S1    155
EQUIVALENCE (C(0416),WLQSD )                                       S4    261
EQUIVALENCE (C(0419),WLQS)                                         S1     22
C(419)=0.                                                          S1     39
EQUIVALENCE (C(0419),WLQS  )                                       S1    156
EQUIVALENCE (C(0419),WLQS)                                         S4     55
C(419)=0.                                                          S4    110
EQUIVALENCE (C(0419),WLQS  )                                       S4    262
EQUIVALENCE (C(0420),WLRSD )                                       S1    157
EQUIVALENCE (C(0420),WLRSD )                                       S4    263
EQUIVALENCE (C(0423),WLRS)                                         S1     23
C(423)=0.                                                          S1     40
EQUIVALENCE (C(0423),WLRS  )                                       S1    158
EQUIVALENCE (C(0423),WLRS)                                         S4     56
C(423)=0.                                                          S4    111
EQUIVALENCE (C(0423),WLRS  )                                       S4    264
EQUIVALENCE (C(0424),BTHTGD)                                       S1    159
EQUIVALENCE (C(0424),BTHTGD)                                       S4    265
EQUIVALENCE (C( 424), BTHTGD),  (C( 427),  BTHTG)                  S2     61
C(403)=0.      $ C(407)=0.      $ C(424)=0.      $ C(428)=0.       S2    198
EQUIVALENCE (C( 424), BTHTGD),  (C( 427),  BTHTG)                  S2    344
EQUIVALENCE (C( 424), BTHTGD),  (C( 427),  BTHTG)                  S3     78
EQUIVALENCE (C( 427),BTHTG )                                       D1     17
EQUIVALENCE (C(0427),BTHTG)                                        S1     24
EQUIVALENCE (C(0427),BTHTG )                                       S1    160
EQUIVALENCE (C(0427),BTHTG)                                        S4     57
EQUIVALENCE (C(0427),BTHTG )                                       S4    266
EQUIVALENCE (C( 424), BTHTGD),  (C( 427),  BTHTG)                  S2     61
EQUIVALENCE (C( 424), BTHTGD),  (C( 427),  BTHTG)                  S2    344
EQUIVALENCE (C( 424), BTHTGD),  (C( 427),  BTHTG)                  S3     78
EQUIVALENCE (C(0428),BPSIGD)                                       S1    161
EQUIVALENCE (C(0428),BPSIGD)                                       S4    267
EQUIVALENCE (C( 428), BPSIGD),  (C( 431),  BPSIG)                  S2     62
C(403)=0.      $ C(407)=0.      $ C(424)=0.      $ C(428)=0.       S2    198
EQUIVALENCE (C( 428), BPSIGD),  (C( 431),  BPSIG)                  S2    345
EQUIVALENCE (C( 428), BPSIGD),  (C( 431),  BPSIG)                  S3     79
EQUIVALENCE (C( 431),BPSIG )                                       D1     18
EQUIVALENCE (C(0431),BPSIG)                                        S1     25
EQUIVALENCE (C(0431),BPSIG )                                       S1    162
EQUIVALENCE (C(0431),BPSIG)                                        S4     58
EQUIVALENCE (C(0431),BPSIG )                                       S4    268
EQUIVALENCE (C( 428), BPSIGD),  (C( 431),  BPSIG)                  S2     62
EQUIVALENCE (C( 428), BPSIGD),  (C( 431),  BPSIG)                  S2    345
EQUIVALENCE (C( 428), BPSIGD),  (C( 431),  BPSIG)                  S3     79
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TABLE 84. (Continued)

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      EQUIVALENCE (C( 433),WLAMQ )                          S4     281
      EQUIVALENCE (C( 434),WLAMR )                          S4     282
      EQUIVALENCE (C(0435),BEPSZ )                          S1     169
      EQUIVALENCE (C( 435),  BEPSZ)                         S4      50
      C(435)=0.                                             S4     119
      EQUIVALENCE (C(0435),BEPSZ )                          S4     283
      C(435)=0.       $ C(436)=0.                           S2     199
      EQUIVALENCE (C( 435),  BEPSZ)                         S2     362
      EQUIVALENCE (C( 435),  BEPSZ)                         S3      90
      EQUIVALENCE (C(0436),BEPSY )                          S1     170
      EQUIVALENCE (C( 436),  BEPSY)                         S4      51
      C(436)=0.                                             S4     120
      EQUIVALENCE (C(0436),BEPSY )                          S4     284
      C(435)=0.       $ C(436)=0.                           S2     199
      EQUIVALENCE (C( 436),  BEPSY)                         S2     363
      EQUIVALENCE (C( 436),  BEPSY)                         S3      91
      EQUIVALENCE (C(0437),WZ    )                          S1     171
      EQUIVALENCE (C(0437),WZ    )                          S4     285
      EQUIVALENCE (C(0438),WY    )                          S1     172
      EQUIVALENCE (C(0438),WY    )                          S4     286
      EQUIVALENCE (C(0439),BGDEFL)                          S1     173
      EQUIVALENCE (C( 445),RLOCK )                          S1     122
      EQUIVALENCE (C( 446),DT    )                          S1     123
      EQUIVALENCE (C( 446),DT    )                          S4      25
      EQUIVALENCE (C( 446),      DT)                        S4      39
      EQUIVALENCE (C( 446),DT    )                          S4     226
10    IF(ABS(C(446)-0.01*AINT(C(446)/0.01+1.E-6)).LT.1.E-6)GO TO 30   C3   9
10    IF(ABS(C(446)-0.01*AINT(C(446)/0.01+1.E-6)).LT.1.E-6)GO TO 30   C3   9
      EQUIVALENCE (C( 447),BDB   )                          S1     124
      EQUIVALENCE (C( 448),CFOVZ )                          S1     125
      EQUIVALENCE (C( 449),CFOVY )                          S1     126
      EQUIVALENCE (C( 450),GSX   )                          S1     127
      EQUIVALENCE (C( 451),SEPS  )                          S1     128
      EQUIVALENCE (C( 451),SEPS  )                          S4      26
      EQUIVALENCE (C( 451),SEPS  )                          S4     227
      EQUIVALENCE (C(452),SWP)                              S1      19
      EQUIVALENCE (C( 452),SWP   )                          S1     129
      EQUIVALENCE (C( 452),SWP   )                          S4      27
      EQUIVALENCE (C(452),SWP)                              S4      59
      EQUIVALENCE (C( 452),SWP   )                          S4     228
      EQUIVALENCE (C(0456),GS    )                          S1     130
      EQUIVALENCE (C(0456),GS    )                          S4      28
      EQUIVALENCE (C(0456),GS    )                          S4     229
      EQUIVALENCE (C(0457),WSL   )                          S1     131
      EQUIVALENCE (C(0457),WSL   )                          S4      29
      EQUIVALENCE (C(0457),WSL   )                          S4     230
```

TABLE 84. (Continued)

EQUIVALENCE (C(0458),WSN)	S1	132
EQUIVALENCE (C(0458),WSN)	S4	30
EQUIVALENCE (C(0458),WSN)	S4	231
EQUIVALENCE (C(0459),WL2)	S1	133
EQUIVALENCE (C(0459),WL2)	S4	31
EQUIVALENCE (C(0459),WL2)	S4	232
EQUIVALENCE (C(460),ST)	S1	135
C(460) = 0.	S4	112
IF(C(460).GT.0.)C(460)=-C(460)	S4	132
IF(C(460).GT.0.)C(460)=-C(460)	S4	132
IF(C(460).GT.0.)C(460)=-C(460)	S4	132
EQUIVALENCE (C(460),ST)	S4	239
C(461)=0.	S1	75
C(461)=1.	S1	80
EQUIVALENCE (C(461),CAGE)	S1	136
C(461) = 0.	S4	169
C(461) = 1.	S4	174
EQUIVALENCE (C(461),CAGE)	C3	42
C(461)=0.	S2	187
C(461)=1.	S2	192
C(462)=0.	S1	76
C(462)=1.	S1	81
EQUIVALENCE (C(462),TKRZ)	S1	137
C(462) = 0.	S4	170
C(462) = 1.	S4	175
EQUIVALENCE (C(462),TKRZ)	C3	43
C(462)=0.	S2	188
C(462)=1.	S2	193
C(463)=0.	S1	77
C(463)=1.	S1	82
EQUIVALENCE (C(463),TKRY)	S1	138
C(463) = 0.	S4	171
C(463) = 1.	S4	176
EQUIVALENCE (C(463),TKRY)	C3	44
C(463)=0.	S2	189
C(463)=1.	S2	194
C(464)=0.	S1	78
C(464)=1.	S1	83
EQUIVALENCE (C(464),TRKZY)	S1	139
C(464) = 0.	S4	172
C(464) = 1.	S4	177
EQUIVALENCE (C(0464),TRKZY)	C1	108
C(464)=0.	S2	190
C(464)=1.	S2	195
EQUIVALENCE (C(465), SDY)	S1	9
EQUIVALENCE (C(465), SDY)	S1	174

TABLE 84. (Continued)

```
EQUIVALENCE (C( 465),    SDY)                                    S4     49
EQUIVALENCE (C( 465),    SDY)                                    S4    240
EQUIVALENCE (C( 466),  SDZ)                                      S1     10
EQUIVALENCE (C( 466),  SDZ)                                      S1    175
EQUIVALENCE (C( 466),    SDZ)                                    S4     48
EQUIVALENCE (C( 466),    SDZ)                                    S4    241
EQUIVALENCE (C( 470), BTGERR)                                    S1      7
EQUIVALENCE (C( 471), BPGERR)                                    S1      8
EQUIVALENCE (C( 480),WLZD  )                                     S4    269
EQUIVALENCE (C( 480),     GQ1),  (C( 482),     GQ2)              S2     41
EQUIVALENCE (C( 480),     GQ1),  (C( 482),     GQ2)              S2    308
EQUIVALENCE (C( 480),     GQ1),  (C( 482),     GQ2)              S3     42
EQUIVALENCE (C( 481),     GR1),  (C( 483),     GR2)              S2     42
EQUIVALENCE (C( 481),     GR1),  (C( 483),     GR2)              S2    309
EQUIVALENCE (C( 481),     GR1),  (C( 483),     GR2)              S3     43
EQUIVALENCE (C( 480),     GQ1),  (C( 482),     GQ2)              S2     41
EQUIVALENCE (C( 480),     GQ1),  (C( 482),     GQ2)              S2    308
EQUIVALENCE (C( 480),     GQ1),  (C( 482),     GQ2)              S3     42
EQUIVALENCE (C( 483),WLZ   )                                     S4     60
C(483) = 0.                                                      S4    187
EQUIVALENCE (C( 483),WLZ   )                                     S4    270
EQUIVALENCE (C( 481),     GR1),  (C( 483),     GR2)              S2     42
EQUIVALENCE (C( 481),     GR1),  (C( 483),     GR2)              S2    309
EQUIVALENCE (C( 481),     GR1),  (C( 483),     GR2)              S3     43
EQUIVALENCE (C( 484),WLYD  )                                     S4    271
EQUIVALENCE (C( 484),     GQ3),  (C( 486),     GQ4)              S2     43
EQUIVALENCE (C( 484),     GQ3),  (C( 486),     GQ4)              S2    310
EQUIVALENCE (C( 484),     GQ3),  (C( 486),     GQ4)              S3     44
EQUIVALENCE (C( 485),     GR3),  (C( 487),     GR4)              S2     44
EQUIVALENCE (C( 485),     GR3),  (C( 487),     GR4)              S2    311
EQUIVALENCE (C( 485),     GR3),  (C( 487),     GR4)              S3     45
EQUIVALENCE (C( 484),     GQ3),  (C( 486),     GQ4)              S2     43
EQUIVALENCE (C( 484),     GQ3),  (C( 486),     GQ4)              S2    310
EQUIVALENCE (C( 484),     GQ3),  (C( 486),     GQ4)              S3     44
EQUIVALENCE (C( 487),WLY   )                                     S4     61
C( 487) = 0.                                                     S4    188
EQUIVALENCE (C( 487),WLY   )                                     S4    272
EQUIVALENCE (C( 485),     GR3),  (C( 487),     GR4)              S2     44
EQUIVALENCE (C( 485),     GR3),  (C( 487),     GR4)              S2    311
EQUIVALENCE (C( 485),     GR3),  (C( 487),     GR4)              S3     45
EQUIVALENCE (C( 488),WLZSDD)                                     S4    273
EQUIVALENCE (C( 489),     GQ5),  (C( 491),     GQ6)              S2     45
EQUIVALENCE (C( 489),     GQ5),  (C( 491),     GQ6)              S2    312
EQUIVALENCE (C( 489),     GQ5),  (C( 491),     GQ6)              S3     46
EQUIVALENCE (C( 490),     GR5),  (C( 492),     GR6)              S2     46
EQUIVALENCE (C( 490),     GR5),  (C( 492),     GR6)              S2    313
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TABLE 84. (Continued)

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EQUIVALENCE (C( 490),     GR5),  (C( 492),     GR6)                    S3      47
C( 491) = 0.                                                           S4     194
EQUIVALENCE (C( 491),WLZSD )                                           S4     274
EQUIVALENCE (C( 489),     GQ5),  (C( 491),     GQ6)                    S2      45
EQUIVALENCE (C( 489),     GQ5),  (C( 491),     GQ6)                    S2     312
EQUIVALENCE (C( 489),     GQ5),  (C( 491),     GQ6)                    S3      46
EQUIVALENCE (C( 490),     GR5),  (C( 492),     GR6)                    S2      46
EQUIVALENCE (C( 490),     GR5),  (C( 492),     GR6)                    S2     313
EQUIVALENCE (C( 490),     GR5),  (C( 492),     GR6)                    S3      47
EQUIVALENCE (C( 493),   DTHCQ),  (C( 494),   DTHCR)                    S2     368
EQUIVALENCE (C( 493),   DTHCQ),  (C( 494),   DTHCR)                    S3      96
EQUIVALENCE (C( 494),WLZS  )                                           S4      62
C( 494) = 0.                                                           S4     195
EQUIVALENCE (C( 494),WLZS  )                                           S4     275
EQUIVALENCE (C( 493),   DTHCQ),  (C( 494),   DTHCR)                    S2     368
EQUIVALENCE (C( 493),   DTHCQ),  (C( 494),   DTHCR)                    S3      96
EQUIVALENCE (C( 495),WLYSDD)                                           S4     276
EQUIVALENCE (C( 495),  DTHRGQ),  (C( 496),  DTHRGR)                    S2     369
EQUIVALENCE (C( 495),  DTHRGQ),  (C( 496),  DTHRGR)                    S3      97
EQUIVALENCE (C( 495),  DTHRGQ),  (C( 496),  DTHRGR)                    S2     369
EQUIVALENCE (C( 495),  DTHRGQ),  (C( 496),  DTHRGR)                    S3      97
EQUIVALENCE (C( 497),   GEOCS)                                         S2      48
EQUIVALENCE (C( 497),   GEOCS)                                         S2     314
EQUIVALENCE (C( 497),   GEOCS)                                         S3      52
C( 498) = 0.                                                           S4     196
EQUIVALENCE (C( 498),WLYSD )                                           S4     277
EQUIVALENCE (C( 500),WCZ   ), (C( 502),WF    ), (C( 505),BF    )       S4      21
EQUIVALENCE (C( 500),WCZ   ), (C( 502),WF    ), (C( 505),BF    )       S4     222
EQUIVALENCE (C( 500),     DQ1),  (C( 503),      Q1)                    S2      63
EQUIVALENCE (C( 500),     DQ1),  (C( 503),      Q1)                    S2     346
EQUIVALENCE (C( 500),     DQ1),  (C( 503),      Q1)                    S3      80
EQUIVALENCE (C( 501),WLYS  )                                           S4      63
C( 501) = 0.                                                           S4     197
EQUIVALENCE (C( 501),WLYS  )                                           S4     278
EQUIVALENCE (C( 501),     DR1),  (C( 504),      R1)                    S2      64
EQUIVALENCE (C( 501),     DR1),  (C( 504),      R1)                    S2     347
EQUIVALENCE (C( 501),     DR1),  (C( 504),      R1)                    S3      81
EQUIVALENCE (C( 500),WCZ   ), (C( 502),WF    ), (C( 505),BF    )       S4      21
EQUIVALENCE (C( 500),WCZ   ), (C( 502),WF    ), (C( 505),BF    )       S4     222
EQUIVALENCE (C( 503),WQP   )                                           S4     290
EQUIVALENCE (C( 500),     DQ1),  (C( 503),      Q1)                    S2      63
EQUIVALENCE (C( 500),     DQ1),  (C( 503),      Q1)                    S2     346
EQUIVALENCE (C( 500),     DQ1),  (C( 503),      Q1)                    S3      80
EQUIVALENCE (C( 504),WRP   )                                           S4     291
EQUIVALENCE (C( 501),     DR1),  (C( 504),      R1)                    S2      64
EQUIVALENCE (C( 501),     DR1),  (C( 504),      R1)                    S2     347
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TABLE 84. (Continued)

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EQUIVALENCE (C( 501),     DR1),  (C( 504),       R1)                     S3      81
EQUIVALENCE (C( 500),WCZ   ), (C( 502),WF     ), (C( 505),BF     )      S4      21
EQUIVALENCE (C( 500),WCZ   ), (C( 502),WF     ), (C( 505),BF     )      S4     222
EQUIVALENCE (C( 506),CROSS )                                             S4      10
EQUIVALENCE (C( 506),CROSS )                                             S4     211
EQUIVALENCE (C( 506),     DQ2),  (C( 509),       Q2)                     S2      65
EQUIVALENCE (C( 506),     DQ2),  (C( 509),       Q2)                     S2     348
EQUIVALENCE (C( 506),     DQ2),  (C( 509),       Q2)                     S3      82
EQUIVALENCE (C( 507),CZETA ), (C( 508),CKSWP ), (C( 509),SGBIAS)        S4      22
EQUIVALENCE (C( 507),CZETA ), (C( 508),CKSWP ), (C( 509),SGBIAS)        S4     223
EQUIVALENCE (C( 507),     DR2),  (C( 510),       R2)                     S2      66
EQUIVALENCE (C( 507),     DR2),  (C( 510),       R2)                     S2     349
EQUIVALENCE (C( 507),     DR2),  (C( 510),       R2)                     S3      83
EQUIVALENCE (C( 507),CZETA ), (C( 508),CKSWP ), (C( 509),SGBIAS)        S4      22
EQUIVALENCE (C( 507),CZETA ), (C( 508),CKSWP ), (C( 509),SGBIAS)        S4     223
EQUIVALENCE (C( 507),CZETA ), (C( 508),CKSWP ), (C( 509),SGBIAS)        S4      22
EQUIVALENCE (C( 509),SGBIAS)                                             S4      34
EQUIVALENCE (C( 507),CZETA ), (C( 508),CKSWP ), (C( 509),SGBIAS)        S4     223
EQUIVALENCE (C( 506),     DQ2),  (C( 509),       Q2)                     S2      65
EQUIVALENCE (C( 506),     DQ2),  (C( 509),       Q2)                     S2     348
EQUIVALENCE (C( 506),     DQ2),  (C( 509),       Q2)                     S3      82
EQUIVALENCE (C( 518),WCN   ), (C( 510),WCL    ), (C( 511),SGSTOT)       S4      23
EQUIVALENCE (C( 518),WCN   ), (C( 510),WCL    ), (C( 511),SGSTOT)       S4     224
EQUIVALENCE (C( 507),     DR2),  (C( 510),       R2)                     S2      66
EQUIVALENCE (C( 507),     DR2),  (C( 510),       R2)                     S2     349
EQUIVALENCE (C( 507),     DR2),  (C( 510),       R2)                     S3      83
EQUIVALENCE (C( 518),WCN   ), (C( 510),WCL    ), (C( 511),SGSTOT)       S4      23
EQUIVALENCE (C( 518),WCN   ), (C( 510),WCL    ), (C( 511),SGSTOT)       S4     224
EQUIVALENCE (C( 512),     DQ3),  (C( 515),       Q3)                     S2      67
EQUIVALENCE (C( 512),     DQ3),  (C( 515),       Q3)                     S2     350
EQUIVALENCE (C( 512),     DQ3),  (C( 515),       Q3)                     S3      84
EQUIVALENCE (C( 513),     DR3),  (C( 516),       R3)                     S2      68
EQUIVALENCE (C( 513),     DR3),  (C( 516),       R3)                     S2     351
EQUIVALENCE (C( 513),     DR3),  (C( 516),       R3)                     S3      85
EQUIVALENCE (C( 514),     DWO),  (C( 517),       WO)                     S2      69
EQUIVALENCE (C( 514),     DWO),  (C( 517),       WO)                     S2     352
EQUIVALENCE (C( 514),     DWO),  (C( 517),       WO)                     S3      86
EQUIVALENCE (C( 512),     DQ3),  (C( 515),       Q3)                     S2      67
EQUIVALENCE (C( 512),     DQ3),  (C( 515),       Q3)                     S2     350
EQUIVALENCE (C( 512),     DQ3),  (C( 515),       Q3)                     S3      84
EQUIVALENCE (C( 513),     DR3),  (C( 516),       R3)                     S2      68
EQUIVALENCE (C( 513),     DR3),  (C( 516),       R3)                     S2     351
EQUIVALENCE (C( 513),     DR3),  (C( 516),       R3)                     S3      85
EQUIVALENCE (C( 514),     DWO),  (C( 517),       WO)                     S2      69
EQUIVALENCE (C( 514),     DWO),  (C( 517),       WO)                     S2     352
EQUIVALENCE (C( 514),     DWO),  (C( 517),       WO)                     S3      86
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TABLE 84. (Continued)

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EQUIVALENCE (C( 518),WCN   ), (C( 510),WCL   ), (C( 511),SGSTOT)   S4     23
EQUIVALENCE (C( 518),WCN   ), (C( 510),WCL   ), (C( 511),SGSTOT)   S4    224
EQUIVALENCE (C( 518),   DDQ4), (C( 521),   DQ4), (C( 524),   Q4) S2     70
EQUIVALENCE (C( 518),   DDQ4), (C( 521),   DQ4), (C( 524),   Q4) S2    353
EQUIVALENCE (C( 519),BLUR  )                                    S4     11
EQUIVALENCE (C( 519),BLUR  )                                    S4    212
EQUIVALENCE (C( 519),   DDR4), (C( 522),   DR4), (C( 525),   R4) S2     71
EQUIVALENCE (C( 519),   DDR4), (C( 522),   DR4), (C( 525),   R4) S2    354
EQUIVALENCE (C( 520),   STOT)                                   S4     41
EQUIVALENCE (C( 520),STOT  )                                    S4    292
EQUIVALENCE (C( 520),    DWI), (C( 523),    WI)                 S2     72
EQUIVALENCE (C( 520),    DWI), (C( 523),    WI)                 S2    355
EQUIVALENCE (C( 520),    DWI), (C( 523),    WI)                 S3     87
EQUIVALENCE (C( 521),   TKDB)                                   S4     38
EQUIVALENCE (C( 521),TKDB  )                                    S4    293
EQUIVALENCE (C( 518),   DDQ4), (C( 521),   DQ4), (C( 524),   Q4) S2     70
EQUIVALENCE (C( 518),   DDQ4), (C( 521),   DQ4), (C( 524),   Q4) S2    353
EQUIVALENCE (C( 522),BNULL2)                                    S4    294
EQUIVALENCE (C( 519),   DDR4), (C( 522),   DR4), (C( 525),   R4) S2     71
EQUIVALENCE (C( 519),   DDR4), (C( 522),   DR4), (C( 525),   R4) S2    354
EQUIVALENCE (C( 523),CKNULL)                                    S4     12
EQUIVALENCE (C( 523),CKNULL)                                    S4    213
EQUIVALENCE (C( 520),    DWI), (C( 523),    WI)                 S2     72
EQUIVALENCE (C( 520),    DWI), (C( 523),    WI)                 S2    355
EQUIVALENCE (C( 520),    DWI), (C( 523),    WI)                 S3     87
EQUIVALENCE (C( 524),STOTSW)                                    S4     13
EQUIVALENCE (C( 524), STOTSW)                                   S4     43
EQUIVALENCE (C( 524),STOTSW)                                    S4    214
EQUIVALENCE (C( 518),   DDQ4), (C( 521),   DQ4), (C( 524),   Q4) S2     70
EQUIVALENCE (C( 518),   DDQ4), (C( 521),   DQ4), (C( 524),   Q4) S2    353
EQUIVALENCE (C( 525),STOTMX)                                    S4     14
EQUIVALENCE (C( 525), STOTMX)                                   S4     40
EQUIVALENCE (C( 525),STOTMX)                                    S4    215
EQUIVALENCE (C( 519),   DDR4), (C( 522),   DR4), (C( 525),   R4) S2     71
EQUIVALENCE (C( 519),   DDR4), (C( 522),   DR4), (C( 525),   R4) S2    354
EQUIVALENCE (C( 526),RDES  )                                    S4     15
EQUIVALENCE (C( 526),RDES  )                                    S4    216
EQUIVALENCE (C( 526),BEPSYSV)                                   S2     81
EQUIVALENCE (C( 526),BEPSYSV)                                   S2    366
EQUIVALENCE (C( 526),BEPSYSV)                                   S3     94
EQUIVALENCE (C( 527),HDES  )                                    S4     16
EQUIVALENCE (C( 527),HDES  )                                    S4    217
EQUIVALENCE (C( 527),   DDQ5), (C( 530),   DQ5), (C( 533),   Q5) S2     73
EQUIVALENCE (C( 527),   DDQ5), (C( 530),   DQ5), (C( 533),   Q5) S2    356
EQUIVALENCE (C( 528),   DDR5), (C( 531),   DR5), (C( 534),   R5) S2     74
EQUIVALENCE (C( 528),   DDR5), (C( 531),   DR5), (C( 534),   R5) S2    357
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TABLE 84. (Continued)

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EQUIVALENCE (C( 529),RVIS  )                                        S4      17
EQUIVALENCE (C( 529),RVIS  )                                        S4      37
EQUIVALENCE (C( 529),RVIS  )                                        S4     218
EQUIVALENCE (C( 529),BEPSZSV)                                       S2      82
EQUIVALENCE (C( 529),BEPSZSV)                                       S2     367
EQUIVALENCE (C( 529),BEPSZSV)                                       S3      95
EQUIVALENCE (C( 530),CPT   )                                        S4      18
EQUIVALENCE (C( 530),CPT   )                                        S4     219
EQUIVALENCE (C( 527),    DDQ5),  (C( 530),    DQ5),  (C( 533),   Q5) S2      73
EQUIVALENCE (C( 527),    DDQ5),  (C( 530),    DQ5),  (C( 533),   Q5) S2     356
EQUIVALENCE (C( 531),ETHR  )                                        S4      19
EQUIVALENCE (C( 531),ETHR  )                                        S4     220
EQUIVALENCE (C( 528),    DDR5),  (C( 531),    DR5),  (C( 534),   R5) S2      74
EQUIVALENCE (C( 528),    DDR5),  (C( 531),    DR5),  (C( 534),   R5) S2     357
EQUIVALENCE (C( 532),EDES  )                                        S4      20
EQUIVALENCE (C( 532),EDES  )                                        S4     221
EQUIVALENCE (C( 532), TIMESV)                                       S2      83
EQUIVALENCE (C( 527),    DDQ5),  (C( 530),    DQ5),  (C( 533),   Q5) S2      73
EQUIVALENCE (C( 527),    DDQ5),  (C( 530),    DQ5),  (C( 533),   Q5) S2     356
EQUIVALENCE (C( 528),    DDR5),  (C( 531),    DR5),  (C( 534),   R5) S2      74
EQUIVALENCE (C( 528),    DDR5),  (C( 531),    DR5),  (C( 534),   R5) S2     357
EQUIVALENCE (C( 535),JVIS  )                                        S4      35
EQUIVALENCE (C( 535),JVIS  )                                        S4     295
EQUIVALENCE (C( 536),KUTD  )                                        S4      36
EQUIVALENCE (C( 536),KUTD  )                                        S4     296
EQUIVALENCE (C( 536),    DDQ6),  (C( 539),    DQ6),  (C( 542),   Q6) S2      75
EQUIVALENCE (C( 536),    DDQ6),  (C( 539),    DQ6),  (C( 542),   Q6) S2     358
EQUIVALENCE (C( 537),    DDR6),  (C( 540),    DR6),  (C( 543),   R6) S2      76
EQUIVALENCE (C( 537),    DDR6),  (C( 540),    DR6),  (C( 543),   R6) S2     359
EQUIVALENCE (C( 538),  INIT)                                        S4      47
EQUIVALENCE (C( 538),  INIT)                                        S4     238
EQUIVALENCE (C( 539),   GSLIM)                                      S4      24
EQUIVALENCE (C( 539),   GSLIM)                                      S4      42
EQUIVALENCE (C( 539),   GSLIM)                                      S4     225
EQUIVALENCE (C( 536),    DDQ6),  (C( 539),    DQ6),  (C( 542),   Q6) S2      75
EQUIVALENCE (C( 536),    DDQ6),  (C( 539),    DQ6),  (C( 542),   Q6) S2     358
EQUIVALENCE (C( 537),    DDR6),  (C( 540),    DR6),  (C( 543),   R6) S2      76
EQUIVALENCE (C( 537),    DDR6),  (C( 540),    DR6),  (C( 543),   R6) S2     359
EQUIVALENCE (C( 536),    DDQ6),  (C( 539),    DQ6),  (C( 542),   Q6) S2      75
EQUIVALENCE (C( 536),    DDQ6),  (C( 539),    DQ6),  (C( 542),   Q6) S2     358
EQUIVALENCE (C( 537),    DDR6),  (C( 540),    DR6),  (C( 543),   R6) S2      76
EQUIVALENCE (C( 537),    DDR6),  (C( 540),    DR6),  (C( 543),   R6) S2     359
EQUIVALENCE (C( 545),     KQ1),  (C( 573),   WTQ1)                  S2      13
EQUIVALENCE (C( 545),     KQ1),  (C( 573),   WTQ1)                  S2     280
EQUIVALENCE (C( 545),     KQ1),  (C( 573),   WTQ1)                  S3      14
EQUIVALENCE (C( 546),     KR1),  (C( 574),   WTR1)                  S2      14
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TABLE 84. (Continued)

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EQUIVALENCE (C( 546),   KR1),  (C( 574),  WTR1)          S2     281
EQUIVALENCE (C( 546),   KR1),  (C( 574),  WTR1)          S3      15
EQUIVALENCE (C( 547),   KQ2),  (C( 575),  WTQ2)          S2      15
EQUIVALENCE (C( 547),   KQ2),  (C( 575),  WTQ2)          S2     282
EQUIVALENCE (C( 547),   KQ2),  (C( 575),  WTQ2)          S3      16
EQUIVALENCE (C( 548),   KR2),  (C( 576),  WTR2)          S2      16
EQUIVALENCE (C( 548),   KR2),  (C( 576),  WTR2)          S2     283
EQUIVALENCE (C( 548),   KR2),  (C( 576),  WTR2)          S3      17
EQUIVALENCE (C( 549),   KQ3),  (C( 577),  WGQ1)          S2      17
EQUIVALENCE (C( 549),   KQ3),  (C( 577),  WGQ1)          S2     284
EQUIVALENCE (C( 549),   KQ3),  (C( 577),  WGQ1)          S3      18
EQUIVALENCE (C( 550),   KR3),  (C( 578),  WGR1)          S2      18
EQUIVALENCE (C( 550),   KR3),  (C( 578),  WGR1)          S2     285
EQUIVALENCE (C( 550),   KR3),  (C( 578),  WGR1)          S3      19
EQUIVALENCE (C( 551),   KQ5),  (C( 579),  WGQ2)          S2      19
EQUIVALENCE (C( 551),   KQ5),  (C( 579),  WGQ2)          S2     286
EQUIVALENCE (C( 551),   KQ5),  (C( 579),  WGQ2)          S3      20
EQUIVALENCE (C( 552),   KR5),  (C( 580),  WGR2)          S2      20
EQUIVALENCE (C( 552),   KR5),  (C( 580),  WGR2)          S2     287
EQUIVALENCE (C( 552),   KR5),  (C( 580),  WGR2)          S3      21
EQUIVALENCE (C( 553),   KQ6),  (C( 581),  WGQ3)          S2      21
EQUIVALENCE (C( 553),   KQ6),  (C( 581),  WGQ3)          S2     288
EQUIVALENCE (C( 553),   KQ6),  (C( 581),  WGQ3)          S3      22
EQUIVALENCE (C( 554),   KR6),  (C( 582),  WGR3)          S2      22
EQUIVALENCE (C( 554),   KR6),  (C( 582),  WGR3)          S2     289
EQUIVALENCE (C( 554),   KR6),  (C( 582),  WGR3)          S3      23
EQUIVALENCE (C( 555),   KQ7),  (C( 583),  WGQ4)          S2      23
EQUIVALENCE (C( 555),   KQ7),  (C( 583),  WGQ4)          S2     290
EQUIVALENCE (C( 555),   KQ7),  (C( 583),  WGQ4)          S3      24
EQUIVALENCE (C( 556),   KR7),  (C( 584),  WGR4)          S2      24
EQUIVALENCE (C( 556),   KR7),  (C( 584),  WGR4)          S2     291
EQUIVALENCE (C( 556),   KR7),  (C( 584),  WGR4)          S3      25
EQUIVALENCE (C( 557),   KQ8),  (C( 585),  WGQ5)          S2      25
EQUIVALENCE (C( 557),   KQ8),  (C( 585),  WGQ5)          S2     292
EQUIVALENCE (C( 557),   KQ8),  (C( 585),  WGQ5)          S3      26
EQUIVALENCE (C( 558),   KR8),  (C( 586),  WGR5)          S2      26
EQUIVALENCE (C( 558),   KR8),  (C( 586),  WGR5)          S2     293
EQUIVALENCE (C( 558),   KR8),  (C( 586),  WGR5)          S3      27
EQUIVALENCE (C( 559),  KQ10),  (C( 587),  WGQ6)          S2      27
EQUIVALENCE (C( 559),  KQ10),  (C( 587),  WGQ6)          S2     294
EQUIVALENCE (C( 559),  KQ10),  (C( 587),  WGQ6)          S3      28
EQUIVALENCE (C( 560),  KR10),  (C( 588),  WGR6)          S2      28
EQUIVALENCE (C( 560),  KR10),  (C( 588),  WGR6)          S2     295
EQUIVALENCE (C( 560),  KR10),  (C( 588),  WGR6)          S3      29
EQUIVALENCE (C( 561),  KQ11),  (C( 589),  WRQ1)          S2      29
EQUIVALENCE (C( 561),  KQ11),  (C( 589),  WRQ1)          S2     296
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TABLE 84. (Continued)

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EQUIVALENCE (C( 561),  KQ11), (C( 589),  WRQ1)                S3     30
EQUIVALENCE (C( 562),  KR11), (C( 590),  WRR1)                S2     30
EQUIVALENCE (C( 562),  KR11), (C( 590),  WRR1)                S2    297
EQUIVALENCE (C( 562),  KR11), (C( 590),  WRR1)                S3     31
EQUIVALENCE (C( 563),  KQ12), (C( 591),  WRQ2)                S2     31
EQUIVALENCE (C( 563),  KQ12), (C( 591),  WRQ2)                S2    298
EQUIVALENCE (C( 563),  KQ12), (C( 591),  WRQ2)                S3     32
EQUIVALENCE (C( 564),  KR12), (C( 592),  WRR2)                S2     32
EQUIVALENCE (C( 564),  KR12), (C( 592),  WRR2)                S2    299
EQUIVALENCE (C( 564),  KR12), (C( 592),  WRR2)                S3     33
EQUIVALENCE (C( 565),    JI), (C( 593),  WRQ3)                S2     33
EQUIVALENCE (C( 565),    JI), (C( 593),  WRQ3)                S2    300
EQUIVALENCE (C( 565),    JI), (C( 593),  WRQ3)                S3     34
EQUIVALENCE (C( 566),    JO), (C( 594),  WRR3)                S2     34
EQUIVALENCE (C( 566),    JO), (C( 594),  WRR3)                S2    301
EQUIVALENCE (C( 566),    JO), (C( 594),  WRR3)                S3     35
EQUIVALENCE (C( 567),   FRI), (C( 595),  WRQ4)                S2     35
EQUIVALENCE (C( 567),   FRI), (C( 595),  WRQ4)                S2    302
EQUIVALENCE (C( 567),   FRI), (C( 595),  WRQ4)                S3     36
EQUIVALENCE (C( 568),   FRO), (C( 596),  WRR4)                S2     36
EQUIVALENCE (C( 568),   FRO), (C( 596),  WRR4)                S2    303
EQUIVALENCE (C( 568),   FRO), (C( 596),  WRR4)                S3     37
EQUIVALENCE (C( 569),   TUI), (C( 597),   RCL)                S2     37
EQUIVALENCE (C( 569),   TUI), (C( 597),   RCL)                S2    304
EQUIVALENCE (C( 569),   TUI), (C( 597),   RCL)                S3     38
EQUIVALENCE (C( 570),   TUO), (C( 598),  TCLQ)                S2     38
EQUIVALENCE (C( 570),   TUO), (C( 598),  TCLQ)                S2    305
EQUIVALENCE (C( 570),   TUO), (C( 598),  TCLQ)                S3     39
EQUIVALENCE (C( 571),  QERG), (C( 599),  TCLR)                S2     39
EQUIVALENCE (C( 571),  QERG), (C( 599),  TCLR)                S2    306
EQUIVALENCE (C( 571),  QERG), (C( 599),  TCLR)                S3     40
EQUIVALENCE (C( 572),  RERG), (C( 600),   TAU)                S2     40
EQUIVALENCE (C( 572),  RERG), (C( 600),   TAU)                S2    307
EQUIVALENCE (C( 572),  RERG), (C( 600),   TAU)                S3     41
EQUIVALENCE (C( 545),   KQ1), (C( 573),  WTQ1)                S2     13
EQUIVALENCE (C( 545),   KQ1), (C( 573),  WTQ1)                S2    280
EQUIVALENCE (C( 545),   KQ1), (C( 573),  WTQ1)                S3     14
EQUIVALENCE (C( 546),   KR1), (C( 574),  WTR1)                S2     14
EQUIVALENCE (C( 546),   KR1), (C( 574),  WTR1)                S2    281
EQUIVALENCE (C( 546),   KR1), (C( 574),  WTR1)                S3     15
EQUIVALENCE (C( 547),   KQ2), (C( 575),  WTQ2)                S2     15
EQUIVALENCE (C( 547),   KQ2), (C( 575),  WTQ2)                S2    282
EQUIVALENCE (C( 547),   KQ2), (C( 575),  WTQ2)                S3     16
EQUIVALENCE (C( 548),   KR2), (C( 576),  WTR2)                S2     16
EQUIVALENCE (C( 548),   KR2), (C( 576),  WTR2)                S2    283
EQUIVALENCE (C( 548),   KR2), (C( 576),  WTR2)                S3     17
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TABLE 84. (Continued)

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      EQUIVALENCE (C( 549),    KQ3),  (C( 577),   WGQ1)                S2      17
      EQUIVALENCE (C( 549),    KQ3),  (C( 577),   WGQ1)                S2     284
      EQUIVALENCE (C( 549),    KQ3),  (C( 577),   WGQ1)                S3      18
      EQUIVALENCE (C( 550),    KR3),  (C( 578),   WGR1)                S2      18
      EQUIVALENCE (C( 550),    KR3),  (C( 578),   WGR1)                S2     285
      EQUIVALENCE (C( 550),    KR3),  (C( 578),   WGR1)                S3      19
      EQUIVALENCE (C( 551),    KQ5),  (C( 579),   WGQ2)                S2      19
      EQUIVALENCE (C( 551),    KQ5),  (C( 579),   WGQ2)                S2     286
      EQUIVALENCE (C( 551),    KQ5),  (C( 579),   WGQ2)                S3      20
      EQUIVALENCE (C( 552),    KR5),  (C( 580),   WGR2)                S2      20
      EQUIVALENCE (C( 552),    KR5),  (C( 580),   WGR2)                S2     287
      EQUIVALENCE (C( 552),    KR5),  (C( 580),   WGR2)                S3      21
      EQUIVALENCE (C( 553),    KQ6),  (C( 581),   WGQ3)                S2      21
      EQUIVALENCE (C( 553),    KQ6),  (C( 581),   WGQ3)                S2     288
      EQUIVALENCE (C( 553),    KQ6),  (C( 581),   WGQ3)                S3      22
      EQUIVALENCE (C( 554),    KR6),  (C( 582),   WGR3)                S2      22
      EQUIVALENCE (C( 554),    KR6),  (C( 582),   WGR3)                S2     289
      EQUIVALENCE (C( 554),    KR6),  (C( 582),   WGR3)                S3      23
      EQUIVALENCE (C( 555),    KQ7),  (C( 583),   WGQ4)                S2      23
      EQUIVALENCE (C( 555),    KQ7),  (C( 583),   WGQ4)                S2     290
      EQUIVALENCE (C( 555),    KQ7),  (C( 583),   WGQ4)                S3      24
      EQUIVALENCE (C( 556),    KR7),  (C( 584),   WGR4)                S2      24
      EQUIVALENCE (C( 556),    KR7),  (C( 584),   WGR4)                S2     291
      EQUIVALENCE (C( 556),    KR7),  (C( 584),   WGR4)                S3      25
      EQUIVALENCE (C( 557),    KQ8),  (C( 585),   WGQ5)                S2      25
      EQUIVALENCE (C( 557),    KQ8),  (C( 585),   WGQ5)                S2     292
      EQUIVALENCE (C( 557),    KQ8),  (C( 585),   WGQ5)                S3      26
      EQUIVALENCE (C( 558),    KR8),  (C( 586),   WGR5)                S2      26
      EQUIVALENCE (C( 558),    KR8),  (C( 586),   WGR5)                S2     293
      EQUIVALENCE (C( 558),    KR8),  (C( 586),   WGR5)                S3      27
      EQUIVALENCE (C( 559),   KQ10),  (C( 587),   WGQ6)                S2      27
      EQUIVALENCE (C( 559),   KQ10),  (C( 587),   WGQ6)                S2     294
      EQUIVALENCE (C( 559),   KQ10),  (C( 587),   WGQ6)                S3      28
      EQUIVALENCE (C( 560),   KR10),  (C( 588),   WGR6)                S2      28
      EQUIVALENCE (C( 560),   KR10),  (C( 588),   WGR6)                S2     295
      EQUIVALENCE (C( 560),   KR10),  (C( 588),   WGR6)                S3      29
      EQUIVALENCE (C( 561),   KQ11),  (C( 589),   WRQ1)                S2      29
      EQUIVALENCE (C( 561),   KQ11),  (C( 589),   WRQ1)                S2     296
      EQUIVALENCE (C( 561),   KQ11),  (C( 589),   WRQ1)                S3      30
      EQUIVALENCE (C( 562),   KR11),  (C( 590),   WRR1)                S2      30
      EQUIVALENCE (C( 562),   KR11),  (C( 590),   WRR1)                S2     297
      EQUIVALENCE (C( 562),   KR11),  (C( 590),   WRR1)                S3      31
      EQUIVALENCE (C( 563),   KQ12),  (C( 591),   WRQ2)                S2      31
      EQUIVALENCE (C( 563),   KQ12),  (C( 591),   WRQ2)                S2     298
      EQUIVALENCE (C( 563),   KQ12),  (C( 591),   WRQ2)                S3      32
      EQUIVALENCE (C( 564),   KR12),  (C( 592),   WRR2)                S2      32
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TABLE 84. (Continued)

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EQUIVALENCE (C( 564),    KR12),  (C( 592),   WRR2)                S2        299
EQUIVALENCE (C( 564),    KR12),  (C( 592),   WRR2)                S3         33
EQUIVALENCE (C( 565),      JI),  (C( 593),   WRQ3)                S2         33
EQUIVALENCE (C( 565),      JI),  (C( 593),   WRQ3)                S2        300
EQUIVALENCE (C( 565),      JI),  (C( 593),   WRQ3)                S3         34
EQUIVALENCE (C( 566),      JO),  (C( 594),   WRR3)                S2         34
EQUIVALENCE (C( 566),      JO),  (C( 594),   WRR3)                S2        301
EQUIVALENCE (C( 566),      JO),  (C( 594),   WRR3)                S3         35
EQUIVALENCE (C( 567),     FRI),  (C( 595),   WRQ4)                S2         35
EQUIVALENCE (C( 567),     FRI),  (C( 595),   WRQ4)                S2        302
EQUIVALENCE (C( 567),     FRI),  (C( 595),   WRQ4)                S3         36
EQUIVALENCE (C( 568),     FRO),  (C( 596),   WRR4)                S2         36
EQUIVALENCE (C( 568),     FRO),  (C( 596),   WRR4)                S2        303
EQUIVALENCE (C( 568),     FRO),  (C( 596),   WRR4)                S3         37
EQUIVALENCE (C( 569),     TUI),  (C( 597),    RCL)                S2         37
EQUIVALENCE (C( 569),     TUI),  (C( 597),    RCL)                S2        304
EQUIVALENCE (C( 569),     TUI),  (C( 597),    RCL)                S3         38
EQUIVALENCE (C( 570),     TUO),  (C( 598),   TCLQ)                S2         38
EQUIVALENCE (C( 570),     TUO),  (C( 598),   TCLQ)                S2        305
EQUIVALENCE (C( 570),     TUO),  (C( 598),   TCLQ)                S3         39
EQUIVALENCE (C( 571),    QERG),  (C( 599),   TCLR)                S2         39
EQUIVALENCE (C( 571),    QERG),  (C( 599),   TCLR)                S2        306
EQUIVALENCE (C( 571),    QERG),  (C( 599),   TCLR)                S3         40
EQUIVALENCE(C(600),IZ)                                            S1         16
EQUIVALENCE (C( 572),    RERG),  (C( 600),    TAU)                S2         40
EQUIVALENCE (C( 572),    RERG),  (C( 600),    TAU)                S2        307
EQUIVALENCE (C( 572),    RERG),  (C( 600),    TAU)                S3         41
EQUIVALENCE (C( 601),   TARHT),  (C( 602),  TARWD)                S2         47
EQUIVALENCE (C( 601),   TARHT),  (C( 602),  TARWD)                S2         50
EQUIVALENCE (C( 601),   TARHT),  (C( 602),  TARWD)                S2        316
EQUIVALENCE (C( 601),   TARHT),  (C( 602),  TARWD)                S3         48
EQUIVALENCE (C( 601),   TARHT),  (C( 602),  TARWD)                S2         47
EQUIVALENCE (C( 601),   TARHT),  (C( 602),  TARWD)                S2         50
EQUIVALENCE (C( 601),   TARHT),  (C( 602),  TARWD)                S2        316
EQUIVALENCE (C( 601),   TARHT),  (C( 602),  TARWD)                S3         48
EQUIVALENCE (C( 603),  RBLOCK),  (C( 605),   IOCS)                S2         49
EQUIVALENCE (C( 603),  RBLOCK),  (C( 605),   IOCS)                S2         79
EQUIVALENCE (C( 603),  RBLOCK),  (C( 605),   IOCS)                S2        315
EQUIVALENCE (C( 603),  RBLOCK),  (C( 605),   IOCS)                S3         51
EQUIVALENCE (C( 604),    FFOV)                                    S2         51
EQUIVALENCE (C( 604),    FFOV)                                    S2        317
EQUIVALENCE (C( 604),    FFOV)                                    S3         50
EQUIVALENCE (C( 603),  RBLOCK),  (C( 605),   IOCS)                S2         49
EQUIVALENCE (C( 603),  RBLOCK),  (C( 605),   IOCS)                S2         79
EQUIVALENCE (C( 603),  RBLOCK),  (C( 605),   IOCS)                S2        315
EQUIVALENCE (C( 603),  RBLOCK),  (C( 605),   IOCS)                S3         51
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TABLE 84. (Continued)

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EQUIVALENCE (C( 606),    TLAG)                                 S2        53
EQUIVALENCE (C( 606),    TLAG)                                 S2       319
EQUIVALENCE (C( 606),    TLAG)                                 S3        53
EQUIVALENCE (C( 607), BRLKQ)                                   S2       371
EQUIVALENCE (C( 607), BRLKQ)                                   S3        99
EQUIVALENCE (C( 608), TDELAY),  (C( 609),   THTQ), (C( 610), THTR) S2    52
EQUIVALENCE (C( 608), TDELAY),  (C( 609),   THTQ), (C( 610), THTR) S2    80
EQUIVALENCE (C( 608), TDELAY),  (C( 609),   THTQ), (C( 610), THTR) S2   318
EQUIVALENCE (C( 608), TDELAY),  (C( 609),   THTQ), (C( 610), THTR) S3    49
EQUIVALENCE (C( 608), TDELAY),  (C( 609),   THTQ), (C( 610), THTR) S2    52
EQUIVALENCE (C( 608), TDELAY),  (C( 609),   THTQ), (C( 610), THTR) S2    80
EQUIVALENCE (C( 608), TDELAY),  (C( 609),   THTQ), (C( 610), THTR) S2   318
EQUIVALENCE (C( 608), TDELAY),  (C( 609),   THTQ), (C( 610), THTR) S3    49
EQUIVALENCE (C( 608), TDELAY),  (C( 609),   THTQ), (C( 610), THTR) S2    52
EQUIVALENCE (C( 608), TDELAY),  (C( 609),   THTQ), (C( 610), THTR) S2    80
EQUIVALENCE (C( 608), TDELAY),  (C( 609),   THTQ), (C( 610), THTR) S2   318
EQUIVALENCE (C( 608), TDELAY),  (C( 609),   THTQ), (C( 610), THTR) S3    49
EQUIVALENCE (C( 611),     KUO),  (C( 612),    KUI)             S2        91
EQUIVALENCE (C( 611),     KUO),  (C( 612),    KUI)             S2       376
EQUIVALENCE (C( 611),     KUO),  (C( 612),    KUI)             S3       104
EQUIVALENCE (C( 611),     KUO),  (C( 612),    KUI)             S2        91
EQUIVALENCE (C( 611),     KUO),  (C( 612),    KUI)             S2       376
EQUIVALENCE (C( 611),     KUO),  (C( 612),    KUI)             S3       104
EQUIVALENCE (C( 613),     KBO),  (C( 614),   KBI)              S2        92
EQUIVALENCE (C( 613),     KBO),  (C( 614),   KBI)              S2       377
EQUIVALENCE (C( 613),     KBO),  (C( 614),   KBI)              S3       105
EQUIVALENCE (C( 613),     KBO),  (C( 614),   KBI)              S2        92
EQUIVALENCE (C( 613),     KBO),  (C( 614),   KBI)              S2       377
EQUIVALENCE (C( 613),     KBO),  (C( 614),   KBI)              S3       105
EQUIVALENCE (C( 615),     KPO),  (C( 616),    KPI)             S2        93
EQUIVALENCE (C( 615),     KPO),  (C( 616),    KPI)             S2       378
EQUIVALENCE (C( 615),     KPO),  (C( 616),    KPI)             S3       106
EQUIVALENCE (C( 615),     KPO),  (C( 616),    KPI)             S2        93
EQUIVALENCE (C( 615),     KPO),  (C( 616),    KPI)             S2       378
EQUIVALENCE (C( 615),     KPO),  (C( 616),    KPI)             S3       106
EQUIVALENCE (C( 617),    KOAO),  (C( 618),   KOAI)             S2        94
EQUIVALENCE (C( 617),    KOAO),  (C( 618),   KOAI)             S2       379
EQUIVALENCE (C( 617),    KOAO),  (C( 618),   KOAI)             S3       107
EQUIVALENCE (C( 617),    KOAO),  (C( 618),   KOAI)             S2        94
EQUIVALENCE (C( 617),    KOAO),  (C( 618),   KOAI)             S2       379
EQUIVALENCE (C( 617),    KOAO),  (C( 618),   KOAI)             S3       107
EQUIVALENCE (C( 619),     UCC),  (C( 620),    USC)             S2        95
EQUIVALENCE (C( 619),     UCC),  (C( 620),    USC)             S2       380
EQUIVALENCE (C( 619),     UCC),  (C( 620),    USC)             S3       108
EQUIVALENCE (C( 619),     UCC),  (C( 620),    USC)             S2        95
EQUIVALENCE (C( 619),     UCC),  (C( 620),    USC)             S2       380
```

TABLE 84. (Continued)

```
EQUIVALENCE (C( 619),    UCC),  (C( 620),    USC)        S3    108
EQUIVALENCE (C( 621),   UCCG),  (C( 622),   USCG)        S2     96
EQUIVALENCE (C( 621),   UCCG),  (C( 622),   USCG)        S2    381
EQUIVALENCE (C( 621),   UCCG),  (C( 622),   USCG)        S3    109
EQUIVALENCE (C( 621),   UCCG),  (C( 622),   USCG)        S2     96
EQUIVALENCE (C( 621),   UCCG),  (C( 622),   USCG)        S2    381
EQUIVALENCE (C( 621),   UCCG),  (C( 622),   USCG)        S3    109
EQUIVALENCE (C(3825),  NCASE),  (C( 625),    IBL)        MC7    33
EQUIVALENCE (C(2020),  LCONV),  (C( 625),    IBL)        S2    370
EQUIVALENCE (C(2020),  LCONV),  (C( 625),    IBL)        S3     98
EQUIVALENCE (C( 626),    VIB)                            A3     33
EQUIVALENCE (C( 626),    VIB)                            A2     51
WRITE(6,600)C(630),PITCH                                 G4     77
C(630)=0.       $ C(631)=0.                              S2    200
IF(ABS(C(630)).LT.ABS(BRLKQ))C(630)=BRLKQ                S2    504
IF(ABS(C(630)).LT.ABS(BRLKQ))C(630)=BRLKQ                S2    504
IF(ABS(C(630)).LT.ABS(BRLKQ))C(630)=BRLKQ                S3    227
IF(ABS(C(630)).LT.ABS(BRLKQ))C(630)=BRLKQ                S3    227
WRITE(6,600)C(631),YAW                                   G4     78
C(630)=0.       $ C(631)=0.                              S2    200
IF(ABS(C(631)).LT.ABS(BRLKR))C(631)=BRLKR                S2    505
IF(ABS(C(631)).LT.ABS(BRLKR))C(631)=BRLKR                S2    505
IF(ABS(C(631)).LT.ABS(BRLKR))C(631)=BRLKR                S3    228
IF(ABS(C(631)).LT.ABS(BRLKR))C(631)=BRLKR                S3    228
EQUIVALENCE(C(650),IY)                                   S1     17
EQUIVALENCE (C( 650),TIMESV)                             S2    337
EQUIVALENCE (C( 650),TIMESV)                             S3     71
C(655)=C(2000)-C(2664)                                   S2    180
EQUIVALENCE (C( 656),  LOSZ)                             S2    338
EQUIVALENCE (C( 656),  LOSZ)                             S3     72
EQUIVALENCE (C( 662),  LOSY)                             S2    339
EQUIVALENCE (C( 662),  LOSY)                             S3     73
EQUIVALENCE (C( 800),BPHISD)                             C1    114
EQUIVALENCE (C( 803),BPHIS )                             C1    115
EQUIVALENCE (C(0804),EZRSDD)                             C1    132
C( 807) = 0.                                             C1     40
EQUIVALENCE (C(0807),EZRSP )                             C1    133
EQUIVALENCE (C(0808),EZRSD )                             C1    134
C( 811) = 0.                                             C1     42
EQUIVALENCE (C(0811),EZRS  )                             C1    135
EQUIVALENCE (C(0812),EYRSDD)                             C1    136
C( 815) = 0.                                             C1     41
EQUIVALENCE (C(0815),EYRSP )                             C1    137
EQUIVALENCE (C(0816),EYRSD )                             C1    138
C( 819) = 0.                                             C1     43
EQUIVALENCE (C(0819),EYRS  )                             C1    139
```

TABLE 84. (Continued)

```
EQUIVALENCE (C(0820),EODCRD)                                   C1    116
C( 823) = 0.                                                   C1     32
EQUIVALENCE (C(0823),EODCR )                                   C1    117
EQUIVALENCE (C(0824),EVNCRD)                                   C1    118
C( 827) = 0.                                                   C1     33
EQUIVALENCE (C(0827),EVNCR )                                   C1    119
C(827)=0.                                                      C3     22
EQUIVALENCE (C( 827),BLQSS)                                    C3     46
EQUIVALENCE (C( 828),EZSDD )                                   C1    120
C(829)=0.    $   C(830)=0.    $   C(833)=0.   $   C(834)=0.    C1     46
EQUIVALENCE (C(0829),AKBQ)                                     C1     98
C(829)=0.    $   C(830)=0.    $   C(833)=0.   $   C(834)=0.    C1     46
EQUIVALENCE (C(0830),AKBR)                                     C1     99
C( 831) = 0.                                                   C1     34
EQUIVALENCE (C( 831),EZSP  )                                   C1    121
C(831)=0.                                                      C3     23
EQUIVALENCE (C( 831),BLRSS)                                    C3     47
EQUIVALENCE(C(832),EZSD)                                       C1    122
C(829)=0.    $   C(830)=0.    $   C(833)=0.   $   C(834)=0.    C1     46
EQUIVALENCE (C(0833),AKPQ)                                     C1    100
C(829)=0.    $   C(830)=0.    $   C(833)=0.   $   C(834)=0.    C1     46
EQUIVALENCE (C(0834),AKPR)                                     C1    101
C( 835) = 0.                                                   C1     35
EQUIVALENCE (C(835),EZS)                                       C1    123
EQUIVALENCE (C(836),EYSDD)                                     C1    124
C(837)=0.    $   C(838)=0.                                     C1     47
EQUIVALENCE (C(0837),AKOAQ)                                    C1    102
C(837)=0.    $   C(838)=0.                                     C1     47
EQUIVALENCE (C(0838),AKOAR)                                    C1    103
C( 839) = 0.                                                   C1     36
EQUIVALENCE (C(839),EYSP)                                      C1    125
EQUIVALENCE (C(840),EYSD)                                      C1    126
EQUIVALENCE (C(841),UCCG)                                      C1     12
EQUIVALENCE (C(841),UCCG)                                      C1    104
EQUIVALENCE (C(842),USCG)                                      C1     13
EQUIVALENCE (C(842),USCG)                                      C1    105
C( 843) = 0.                                                   C1     37
EQUIVALENCE (C( 843),EYS    )                                  C1    127
EQUIVALENCE (C(0848),NHSUM )                                   C1      9
EQUIVALENCE (C(0850),HLIMO )                                   C1     76
EQUIVALENCE (C(0851),HLIME )                                   C1     77
EQUIVALENCE (C(0852),QBIAS )                                   C1     78
EQUIVALENCE (C(0853),RBIAS )                                   C1     79
EQUIVALENCE (C(0854),GBIAS )                                   C1     80
EQUIVALENCE (C(855),GY)                                        C1     82
EQUIVALENCE (C(0856),BDELTC)                                   C1    145
```

TABLE 84. (Continued)

```
EQUIVALENCE (C(856),BDELTC)                          C3      56
EQUIVALENCE (C( 856),BDELTC)                         C4      87
EQUIVALENCE (C( 856),BDELTC)                         C5      80
EQUIVALENCE (C( 860),TDY  )                          C3      31
EQUIVALENCE (C(0861),WP1    )                        C1      83
EQUIVALENCE (C( 861),GBIAS)                          C3      32
EQUIVALENCE (C(0862),DP1    )                        C1      84
EQUIVALENCE (C(0863),TAUZ   )                        C1      85
EQUIVALENCE (C(0864),TAUY   )                        C1      86
EQUIVALENCE (C(0865),HLIMP  )                        C1      87
EQUIVALENCE (C(0866),TDY    )                        C1      88
EQUIVALENCE (C(0867),GZ)                             C1      81
EQUIVALENCE (C(0868),EYRR   )                        C1     150
EQUIVALENCE (C(0869),WQC    )                        C1     147
EQUIVALENCE (C(0870),WRC    )                        C1     148
EQUIVALENCE (C( 870),HJK)                            C3      33
EQUIVALENCE (C(0871),WQ1    )                        C1      89
EQUIVALENCE (C(0872),DQ1    )                        C1      90
EQUIVALENCE (C(0875),BDELPC)                         C1     151
EQUIVALENCE (C(0876),EZRR   )                        C1     149
EQUIVALENCE (C( 877),TAUL   )                        C1      91
EQUIVALENCE (C( 878),QBIAS)                          C3      34
EQUIVALENCE (C( 879),RBIAS)                          C3      35
EQUIVALENCE (C( 880),EZSSD )                         C1     128
EQUIVALENCE (C( 880),BXX)                            C3      48
EQUIVALENCE (C( 881),BJJ)                            C3      49
EQUIVALENCE (C( 882),BKK)                            C3      50
C( 883) = 0.                                         C1      38
EQUIVALENCE (C( 883),EZSS   )                        C1     129
EQUIVALENCE (C( 883),BXXSS)                          C3      51
EQUIVALENCE (C( 884),EYSSD )                         C1     130
EQUIVALENCE (C( 884),BJJSS)                          C3      52
EQUIVALENCE (C( 885),BKKSS)                          C3      53
EQUIVALENCE (C( 886),BTHTS)                          C3      54
C( 887) = 0.                                         C1      39
EQUIVALENCE (C( 887),EYSS   )                        C1     131
EQUIVALENCE (C( 887),BPSIS)                          C3      55
EQUIVALENCE (C(0888),BPISDD)                         C1     140
EQUIVALENCE (C( 890),HXX)                            C3      36
C( 891) = 0.                                         C1      44
EQUIVALENCE (C(0891),BPISP )                         C1     141
EQUIVALENCE (C(0892),BPISD )                         C1     142
C( 895) = 0.                                         C1      45
EQUIVALENCE (C(0895),BPIS   )                        C1     143
EQUIVALENCE (C(1000),RMISST)                         MC7     27
C(1100) = BDELTD(1)                                  C4     115
```

TABLE 84. (Continued)

```
C(1100)=BDELTD(1)                                                   C5     135
EQUIVALENCE (C(1101),FELECB)                                        C4      17
EQUIVALENCE (C(1102),FELECQB)                                       C4      18
EQUIVALENCE (C(1103),BSURF1)                                        A1      17
EQUIVALENCE (C(1103),BDELT1)                                        C4      13
BDELT(1)=C(1103)                                                    C4      96
C(1103) = BDELT(1)                                                  C4     109
EQUIVALENCE (C(1103),BDELT1)                                        C5      15
C(1103)=0.                                                          C5      44
BDELT(1)=C(1103)                                                    C5      93
C(1103)=BDELT(1)                                                    C5     129
C(1104) = BDELTD(2)                                                 C4     116
C(1104)=BDELTD(2)                                                   C5     136
EQUIVALENCE (C(1105),FELECRB)                                       C4      19
EQUIVALENCE (C(1106),FMECHB)                                        C4      20
EQUIVALENCE (C(1107),BSURF2)                                        A1      18
EQUIVALENCE (C(1107),BDELT2)                                        C4      14
BDELT(2)=C(1107)                                                    C4      97
C(1107) = BDELT(2)                                                  C4     110
EQUIVALENCE (C(1107),BDELT2)                                        C5      16
C(1107)=0.                                                          C5      45
BDELT(2)=C(1107)                                                    C5      94
C(1107)=BDELT(2)                                                    C5     130
C(1108) = BDELTD(3)                                                 C4     117
C(1108)=BDELTD(3)                                                   C5     137
EQUIVALENCE (C(1109),FMECHQB)                                       C4      21
EQUIVALENCE (C(1110),FMECHRB)                                       C4      22
EQUIVALENCE (C(1111),BSURF3)                                        A1      19
EQUIVALENCE (C(1111),BDELT3)                                        C4      15
BDELT(3)=C(1111)                                                    C4      98
C(1111) = BDELT(3)                                                  C4     111
EQUIVALENCE (C(1111),BDELT3)                                        C5      17
C(1111)=0.                                                          C5      46
BDELT(3)=C(1111)                                                    C5      95
C(1111)=BDELT(3)                                                    C5     131
C(1112) = BDELTD(4)                                                 C4     118
C(1112)=BDELTD(4)                                                   C5     138
EQUIVALENCE (C(1115),BSURF4)                                        A1      20
EQUIVALENCE (C(1115),BDELT4)                                        C4      16
BDELT(4)=C(1115)                                                    C4      99
C(1115) = BDELT(4)                                                  C4     112
EQUIVALENCE (C(1115),BDELT4)                                        C5      18
C(1115)=0.                                                          C5      47
BDELT(4)=C(1115)                                                    C5      96
C(1115)=BDELT(4)                                                    C5     132
WRITE (6,30) C(2000),C(367),C(368),C(204),C(369),C(370),C(1117),    EXEC   282
```

TABLE 84. (Continued)

```
C C(1118),C(1119),C(1120)                                    EXEC   283
C C(1118),C(1119),C(1120)                                    EXEC   283
  EQUIVALENCE (C(1120),G1)                                   C5       8
  EQUIVALENCE (C(1120),G1)                                   C5      72
C C(1118),C(1119),C(1120)                                    EXEC   283
  EQUIVALENCE (C(1124),ZN)                                   C5       9
  EQUIVALENCE (C(1124),ZN)                                   C5      73
  EQUIVALENCE (C(1128),W1)                                   C5      10
  EQUIVALENCE (C(1128),W1)                                   C5      74
  EQUIVALENCE (C(1132),G2)                                   C5      11
  EQUIVALENCE (C(1132),G2)                                   C5      75
  EQUIVALENCE (C(1136),WN)                                   C5      12
  EQUIVALENCE (C(1136),WN)                                   C5      76
  EQUIVALENCE (C(1140),OPTACT)                               C4      26
  EQUIVALENCE (C(1140),OPTACT)                               C5      67
  C(1141)=0.   $   C(1142)=0.   $   C(1143)=0.               C5      56
  EQUIVALENCE (C(1141),BDP)                                  C5      68
  C(1141)=0.   $   C(1142)=0.   $   C(1143)=0.               C5      56
  EQUIVALENCE (C(1142),BDQ)                                  C5      69
  EQUIVALENCE (C(1143),WDELTL)                               C4       7
  EQUIVALENCE (C(1143),WDELTL)                               C4      83
  C(1141)=0.   $   C(1142)=0.   $   C(1143)=0.               C5      56
  EQUIVALENCE (C(1143),BDR)                                  C5      70
  EQUIVALENCE (C(1144),GDELT)                                C4       8
  EQUIVALENCE (C(1144),GDELT)                                C4      84
  EQUIVALENCE (C(1147),HDEL)                                 C5      13
  EQUIVALENCE (C(1147),HDEL)                                 C5      71
  C(1160)=WDS2D(1)                                           C5     139
  C(1163)=0.                                                 C5      48
  WDS2 (1)=C(1163)                                           C5      97
  C(1164)=WDS2D(2)                                           C5     140
  C(1167)=0.                                                 C5      49
  WDS2 (2)=C(1167)                                           C5      98
  C(1168)=WDS2D(3)                                           C5     141
  C(1171)=0.                                                 C5      50
  WDS2 (3)=C(1171)                                           C5      99
  C(1172)=WDS2D(4)                                           C5     142
  C(1175)=0.                                                 C5      51
  WDS2 (4)=C(1175)                                           C5     100
  C(1176)=WDS1D(1)                                           C5     143
  C(1179)=0.                                                 C5      52
  WDS1 (1)=C(1179)                                           C5     101
  C(1180)=WDS1D(2)                                           C5     144
  C(1183)=0.                                                 C5      53
  WDS1 (2)=C(1183)                                           C5     102
  C(1184)=WDS1D(3)                                           C5     145
```

TABLE 84. (Continued)

```
C(1187)=0.                                          C5      54
WDS1 (3)=C(1187)                                    C5     103
C(1188)=WDS1D(4)                                    C5     146
C(1191)=0.                                          C5      55
WDS1 (4)=C(1191)                                    C5     104
EQUIVALENCE (C(1203),CX    )                        A1      25
EQUIVALENCE (C(1203),CX    )                        A2      26
EQUIVALENCE (C(1204),CY    )                        A1      50
EQUIVALENCE (C(1204),CY    )                        A2      27
EQUIVALENCE (C(1205),CZ    )                        A1      51
EQUIVALENCE (C(1205),CZ    )                        A2      28
EQUIVALENCE (C(1206),CLP   )                        A1      35
EQUIVALENCE (C(1206),CLP   )                        A2      29
EQUIVALENCE (C(1207),CMQ   )                        A1      36
EQUIVALENCE (C(1207),CMQ   )                        A2      30
EQUIVALENCE (C(1208),CNR   )                        A1      37
EQUIVALENCE (C(1208),CNR   )                        A2      31
EQUIVALENCE (C(1209),CL    )                        A1      38
EQUIVALENCE (C(1209),CL    )                        A2      32
EQUIVALENCE (C(1210),CM    )                        A1      39
EQUIVALENCE (C(1210),CM    )                        A2      33
EQUIVALENCE (C(1211),CN    )                        A1      40
EQUIVALENCE (C(1211),CN    )                        A2      34
EQUIVALENCE (C(1212),CX0   )                        A1      26
EQUIVALENCE (C(1213),CXC   )                        A1      27
EQUIVALENCE (C(1214),CNPT  )                        A1      28
EQUIVALENCE (C(1215),CY2   )                        A1      29
EQUIVALENCE (C(1217),CM0   )                        A1      41
EQUIVALENCE (C(1218),CN2   )                        A1      42
EQUIVALENCE (C(1219),CZQ   )                        A1      52
EQUIVALENCE (C(1220),CZR   )                        A1      53
EQUIVALENCE (C(1221),CMDQP )                        A1      54
EQUIVALENCE (C(1222),CMR   )                        A1      55
EQUIVALENCE (C(1223),CYR   )                        A1      56
EQUIVALENCE (C(1224),CYQ   )                        A1      57
EQUIVALENCE (C(1225),CLDRP )                        A1      58
EQUIVALENCE (C(1226),CNQ   )                        A1      59
EQUIVALENCE (C(1227),CLD   )                        A1      60
EQUIVALENCE (C(1228),CLMP  )                        A1      61
EQUIVALENCE (C(1229),CLNP  )                        A1      62
EQUIVALENCE (C(1230),BDEFL )                        A1      30
EQUIVALENCE (C(1231),BDL)                           A1      63
EQUIVALENCE (C(1231),BDP   )                        C4      27
EQUIVALENCE (C(1231),BDP)                           C5      19
EQUIVALENCE (C(1232),BDM)                           A1      64
EQUIVALENCE (C(1232),BDQ   )                        C4      28
```

TABLE 84. (Continued)

EQUIVALENCE (C(1232),BDQ)	C5	20
EQUIVALENCE (C(1233),BDN)	A1	65
EQUIVALENCE (C(1233),BDR)	C4	29
EQUIVALENCE (C(1233),BDR)	C5	21
EQUIVALENCE (C(1234),CDCM)	A1	43
EQUIVALENCE (C(1235),CDCN)	A1	31
EQUIVALENCE (C(1240),CL2)	A1	44
EQUIVALENCE (C(1241),CL3)	A1	45
EQUIVALENCE (C(1244),CNPU)	A1	32
EQUIVALENCE (C(1245),CYPU)	A1	33
EQUIVALENCE (C(1247),CMP)	A1	46
EQUIVALENCE (C(1248),CNP)	A1	47
EQUIVALENCE (C(1249),CLR)	A1	48
EQUIVALENCE (C(1250),CZP)	A1	66
EQUIVALENCE (C(1251),CYP)	A1	67
EQUIVALENCE (C(1254), DELTB)	C4	23
EQUIVALENCE (C(1254), DELTB)	C4	88
EQUIVALENCE (C(1255),DELTQB)	C4	24
EQUIVALENCE (C(1255),DELTQB)	C4	89
EQUIVALENCE (C(1256),DELTRB)	C4	25
EQUIVALENCE (C(1256),DELTRB)	C4	90
EQUIVALENCE (C(1270),BDMO)	A1	69
EQUIVALENCE (C(1271),BDNO)	A1	68
EQUIVALENCE (C(1300),FXBA)	A2	57
EQUIVALENCE (C(1300),FXBA)	D1	262
EQUIVALENCE (C(1301),FYBA)	A2	58
EQUIVALENCE (C(1301),FYBA)	D1	263
EQUIVALENCE (C(1302),FZBA)	A2	59
EQUIVALENCE (C(1302),FZBA)	D1	264
EQUIVALENCE (C(1303),FMXBA)	A2	60
EQUIVALENCE (C(1303),FMXBA)	D2	77
EQUIVALENCE (C(1304),FMYBA)	A2	61
EQUIVALENCE (C(1304),FMYBA)	D2	78
EQUIVALENCE (C(1305),FMZBA)	A2	62
EQUIVALENCE (C(1305),FMZBA)	D2	79
EQUIVALENCE (C(1306),RFAREA)	A2	9
EQUIVALENCE (C(1307),RFLGTH)	A2	10
EQUIVALENCE (C(1308),RDELCG)	A3	10
EQUIVALENCE (C(1308),RDELCG)	A3	117
EQUIVALENCE (C(1308),RDELCG)	A2	63
EQUIVALENCE (C(1313),RFXCG)	A3	96
EQUIVALENCE (C(1314),RFYCG)	A3	97
EQUIVALENCE (C(1315),RFZCG)	A3	98
EQUIVALENCE (C(1316),RLUG)	A2	11
EQUIVALENCE (C(1317),RAIL)	G5	11
EQUIVALENCE (C(1317),RAIL)	A2	12

TABLE 84. (Continued)

```
EQUIVALENCE (C(1320),FMXTH )                                   A3      11
EQUIVALENCE (C(1320),FMXTH )                                   A3     118
EQUIVALENCE (C(1320),FMXTH )                                   A2      35
EQUIVALENCE (C(1321),FMYTH )                                   A3      12
EQUIVALENCE (C(1321),FMYTH )                                   A3     119
EQUIVALENCE (C(1321),FMYTH )                                   A2      36
EQUIVALENCE (C(1322),FMZTH )                                   A3      13
EQUIVALENCE (C(1322),FMZTH )                                   A3     120
EQUIVALENCE (C(1322),FMZTH )                                   A2      37
EQUIVALENCE (C(1323),FMXLUG)                                   A2      70
EQUIVALENCE (C(1324),FMYLUG)                                   A2      71
EQUIVALENCE (C(1325),FMZLUG)                                   A2      72
EQUIVALENCE (C(1332),CPHAS )                                   A2      14
EQUIVALENCE (C(1401),BALPHT)                                   A3      99
EQUIVALENCE (C(1402),BPHIT )                                   A3     100
EQUIVALENCE (C(1403),QNALGN)                                   A3     101
EQUIVALENCE (C(1404),PCFTH )                                   A3     102
EQUIVALENCE (C(1405),QBURN )                                   G5      12
EQUIVALENCE (C(1405),QBURN )                                   A3      14
EQUIVALENCE (C(1405),QBURN )                                   A3     103
EQUIVALENCE (C(1405),QBURN )                                   A2      15
EQUIVALENCE (C(1409),UDWP  )                                   A3     121
EQUIVALENCE (C(1410),FTHRST)                                   A3     122
EQUIVALENCE (C(1411),FTHX  )                                   A3      15
EQUIVALENCE (C(1411),FTHX  )                                   A3     123
EQUIVALENCE (C(1411),FTHX  )                                   A2      38
EQUIVALENCE (C(1412),FTHY  )                                   A3      16
EQUIVALENCE (C(1412),FTHY  )                                   A3     124
EQUIVALENCE (C(1412),FTHY  )                                   A2      39
EQUIVALENCE (C(1413),FTHZ  )                                   A3      17
EQUIVALENCE (C(1413),FTHZ  )                                   A3     125
EQUIVALENCE (C(1413),FTHZ  )                                   A2      40
EQUIVALENCE (C(1414),CISP  )                                   A3     104
EQUIVALENCE (C(1415),DWT   )                                   A3      18
EQUIVALENCE (C(1415),DWT   )                                   A3     105
EQUIVALENCE (C(1416),DWP   )                                   A3     106
EQUIVALENCE (C(1417),RDCGO )                                   A3     107
EQUIVALENCE (C(1418),RDCGF )                                   A3      19
EQUIVALENCE (C(1418),RDCGF )                                   A3     108
EQUIVALENCE (C(1419),FMIXF )                                   A3      20
EQUIVALENCE (C(1419),FMIXO)                                    A3     109
EQUIVALENCE (C(1420),FMIYF )                                   A3      21
EQUIVALENCE (C(1420),FMIYO)                                    A3     110
EQUIVALENCE (C(1421),RLCGO )                                   A3     111
EQUIVALENCE (C(1422),RLCG  )                                   A3     126
EQUIVALENCE (C(1422),RLCG  )                                   A2      41
```

TABLE 84. (Continued)

```
EQUIVALENCE (C(1496),UIMPD )                                         A3       133
C(1499) = 0.                                                         A3        38
EQUIVALENCE (C(1499),UIMP  )                                         A3       134
EQUIVALENCE (C(1560), SXPDD)                                         G5        38
EQUIVALENCE (C(1560), SXPDD)                                         SPOT      61
EQUIVALENCE (C(1561),   RSX)                                         MCARLO     5
EQUIVALENCE (C(1561),    RX)                                         G5        39
EQUIVALENCE (C(1561),    RX)                                         SPOT      62
EQUIVALENCE (C(1562),GSPOTY)                                         G5        40
EQUIVALENCE (C(1562),GSPOTY)                                         SPOT      11
EQUIVALENCE (C(1562),GSPOTY)                                         SPOT      63
EQUIVALENCE (C(1562),GSPOTY)                                         D1        76
EQUIVALENCE (C(1563),  SXPD)                                         G5        41
C(1563)=0.   $   C(1566)=0.   $   C(1573)=0.   $   C(1576)=0.        SPOT      48
EQUIVALENCE (C(1563),  SXPD)                                         SPOT      64
EQUIVALENCE (C(1564),YMC)                                            MCARLO     8
EQUIVALENCE (C(1564),YMC)                                            G4        20
EQUIVALENCE (C(1565),YMC2)                                           MCARLO     9
EQUIVALENCE (C(1565),YMC2)                                           G4        21
EQUIVALENCE (C(1566),   SXP)                                         G5        42
C(1563)=0.   $   C(1566)=0.   $   C(1573)=0.   $   C(1576)=0.        SPOT      48
EQUIVALENCE (C(1566),   SXP)                                         SPOT      65
C(1567) = 0.                                                         SPOT      20
C(1567) = 0.                                                         D1        84
WRITE(6,500) C(1567), C(1568), C(1577), C(1578)                      G4        84
IF(C(1680).GT.C(1567)) C(1567) = C(1680)                             IO       208
IF(C(1680).GT.C(1567)) C(1567) = C(1680)                             IO       208
C(1568) = 0.                                                         SPOT      21
C(1568) = 0.                                                         D1        85
WRITE(6,500) C(1567), C(1568), C(1577), C(1578)                      G4        84
IF(C(1680).LT.C(1568)) C(1568) = C(1680)                             IO       209
IF(C(1680).LT.C(1568)) C(1568) = C(1680)                             IO       209
EQUIVALENCE (C(1570), SYPDD)                                         G5        43
EQUIVALENCE (C(1570), SYPDD)                                         SPOT      66
EQUIVALENCE (C(1571),   RSY)                                         MCARLO     6
EQUIVALENCE (C(1571),    RY)                                         G5        44
EQUIVALENCE (C(1571),    RY)                                         SPOT      67
EQUIVALENCE (C(1572),GSPOTZ)                                         G5        45
EQUIVALENCE (C(1572),GSPOTZ)                                         SPOT      12
EQUIVALENCE (C(1572),GSPOTZ)                                         SPOT      68
EQUIVALENCE (C(1572),GSPOTZ)                                         D1        77
EQUIVALENCE (C(1573),  SYPD)                                         G5        46
C(1563)=0.   $   C(1566)=0.   $   C(1573)=0.   $   C(1576)=0.        SPOT      48
EQUIVALENCE (C(1573),  SYPD)                                         SPOT      69
EQUIVALENCE (C(1574),ZMC)                                            MCARLO    10
EQUIVALENCE (C(1574),ZMC)                                            G4        22
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TABLE 84. (Continued)

```
EQUIVALENCE (C(1575),ZMC2)                                      MCARLO    11
EQUIVALENCE (C(1575),ZMC2)                                      G4        23
EQUIVALENCE (C(1576),   SYP)                                    G5        47
C(1563)=0.   $   C(1566)=0.   $   C(1573)=0.   $   C(1576)=0.   SPOT      48
EQUIVALENCE (C(1576),   SYP)                                    SPOT      70
C(1577) = 0.                                                    SPOT      22
C(1577) = 0.                                                    D1        86
WRITE(6,500) C(1567), C(1568), C(1577), C(1578)                 G4        84
IF(C(1681).GT.C(1577)) C(1577) = C(1681)                        IO       210
IF(C(1681).GT.C(1577)) C(1577) = C(1681)                        IO       210
C(1578) = 0.                                                    SPOT      23
C(1578) = 0.                                                    D1        87
WRITE(6,500) C(1567), C(1568), C(1577), C(1578)                 G4        84
IF(C(1681).LT.C(1578)) C(1578) = C(1681)                        IO       211
IF(C(1681).LT.C(1578)) C(1578) = C(1681)                        IO       211
EQUIVALENCE (C(1579),   ZETA)                                   G5        48
EQUIVALENCE (C(1579),   ZETA)                                   SPOT      14
EQUIVALENCE (C(1579),   ZETA)                                   SPOT      71
EQUIVALENCE (C(1579),   ZETA)                                   D1        79
EQUIVALENCE (C(1580),     W0)                                   G5        49
EQUIVALENCE (C(1580),     W0)                                   SPOT      15
EQUIVALENCE (C(1580),     W0)                                   SPOT      72
EQUIVALENCE (C(1580),     W0)                                   D1        80
EQUIVALENCE (C(1581),SIGSPOT)                                   SPOT      13
EQUIVALENCE (C(1581),SIGSPOT)                                   D1        78
EQUIVALENCE (C(1600),VXED  )                                    D1       277
EQUIVALENCE (C(1603),    VXE)                                   G2        21
EQUIVALENCE (C(1603),VXE   )                                    G3        11
EQUIVALENCE (C(1603),VXE   )                                    G5        13
EQUIVALENCE (C(1603),VXE   )                                    D1        32
EQUIVALENCE (C(1603),VXE   )                                    D1       278
EQUIVALENCE (C(1604),VYED  )                                    D1       279
EQUIVALENCE (C(1607),    VYE)                                   G2        22
EQUIVALENCE (C(1607),VYE   )                                    G3        12
EQUIVALENCE (C(1607),VYE   )                                    G5        14
EQUIVALENCE (C(1607),VYE   )                                    D1        33
EQUIVALENCE (C(1607),VYE   )                                    D1       280
EQUIVALENCE (C(1608),VZED  )                                    D1       281
EQUIVALENCE (C(1611),    VZE)                                   G2        23
EQUIVALENCE (C(1611),VZE   )                                    G3        13
EQUIVALENCE (C(1611),VZE   )                                    G5        15
EQUIVALENCE (C(1611),VZE   )                                    D1        34
EQUIVALENCE (C(1611),VZE   )                                    D1       282
EQUIVALENCE (C(1612),RXED  )                                    D1       283
EQUIVALENCE (C(1615),RXE   )                                    G5        16
EQUIVALENCE (C(1615),RXE   )                                    D1        29
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TABLE 84. (Continued)

```
EQUIVALENCE (C(1615),RXE   )                                          D1    284
EQUIVALENCE (C( 371),RANGE),(C(1615),RXE),(C(1623),RZE)               S4     76
EQUIVALENCE (C(1615),RXE   )                                          S4    252
EQUIVALENCE (C(1616),RYED  )                                          D1    285
EQUIVALENCE (C(1619),RYE   )                                          G5     17
EQUIVALENCE (C(1619),RYE   )                                          D1     30
EQUIVALENCE (C(1619),RYE   )                                          D1    286
EQUIVALENCE (C(1619),RYE   )                                          S4    251
EQUIVALENCE (C(1620),RZED  )                                          D1    287
EQUIVALENCE (C(1623),RZE  )                                           G3     14
EQUIVALENCE (C(1623),RZE   )                                          G5     18
EQUIVALENCE (C(1623),RZE   )                                          D1     31
EQUIVALENCE (C(1623),RZE  )                                           D1    288
EQUIVALENCE (C( 371),RANGE),(C(1615),RXE),(C(1623),RZE)               S4     76
EQUIVALENCE (C(1623),RZE   )                                          S4    250
EQUIVALENCE (C(1624),AXBA  )                                          D1    301
EQUIVALENCE (C(1625),AYBA  )                                          D1    302
EQUIVALENCE (C(1626),AZBA  )                                          D1    303
EQUIVALENCE (C(1627),AGRAV )                                          A2     16
EQUIVALENCE (C(1627),AGRAV )                                          D1    252
EQUIVALENCE (C(1628),DMASS )                                          A3     22
EQUIVALENCE (C(1628),DMASS )                                          A3    127
EQUIVALENCE (C(1628),DMASS )                                          A2     64
EQUIVALENCE (C(1628),DMASS )                                          D1    253
EQUIVALENCE (C(1629),ATHRST)                                          D1    254
EQUIVALENCE (C(1630),ATURNT)                                          D1    255
EQUIVALENCE (C(1631),BGAMT )                                          D1    256
EQUIVALENCE (C(1632),VDELX )                                          D1    304
EQUIVALENCE (C(1633),VDELY )                                          D1    305
EQUIVALENCE (C(1634),VDELZ )                                          D1    306
EQUIVALENCE (C(1635),RDELX )                                          G5     19
EQUIVALENCE (C(1635), RDELX)                                          D1     48
EQUIVALENCE (C(1635),RDELX )                                          D1    307
*,          (C(1635),RDELX )                                          G4     16
RANGE=SQRT(C(1635)*C(1635)+C(1636)*C(1636)+C(1637)*C(1637))           S2    218
RANGE=SQRT(C(1635)*C(1635)+C(1636)*C(1636)+C(1637)*C(1637))           S2    218
EQUIVALENCE (C(1636),RDELY )                                          G5     20
EQUIVALENCE (C(1636), RDELY)                                          D1     49
EQUIVALENCE (C(1636),RDELY )                                          D1    308
*,          (C(1636),RDELY )                                          G4     17
RANGE=SQRT(C(1635)*C(1635)+C(1636)*C(1636)+C(1637)*C(1637))           S2    218
RANGE=SQRT(C(1635)*C(1635)+C(1636)*C(1636)+C(1637)*C(1637))           S2    218
EQUIVALENCE (C(1637),RDELZ )                                          G5     21
EQUIVALENCE (C(1637), RDELZ)                                          D1     50
EQUIVALENCE (C(1637),RDELZ )                                          D1    309
*,          (C(1637),RDELZ )                                          G4     18
```

TABLE 84. (Continued)

RANGE=SQRT(C(1635)*C(1635)+C(1636)*C(1636)+C(1637)*C(1637))	S2	218
RANGE=SQRT(C(1635)*C(1635)+C(1636)*C(1636)+C(1637)*C(1637))	S2	218
EQUIVALENCE (C(1638),VCLSNG)	D1	310
EQUIVALENCE (C(1639),OPTARG)	D1	19
EQUIVALENCE (C(1639),OPTARG)	D1	257
EQUIVALENCE (C(1640),VTARGD)	D1	289
EQUIVALENCE (C(1643),VTARG)	D1	290
EQUIVALENCE (C(1644),BPSITD)	D1	291
EQUIVALENCE (C(1647),BPSIT)	D1	292
EQUIVALENCE (C(1648),RTXED)	D1	293
EQUIVALENCE (C(1651),RTXE)	G5	22
EQUIVALENCE (C(1651),RTXE)	D1	35
EQUIVALENCE (C(1651),RTXE)	D1	294
EQUIVALENCE (C(1652),RTYED)	D1	295
EQUIVALENCE (C(1655),RTYE)	G5	23
EQUIVALENCE (C(1655),RTYE)	D1	36
EQUIVALENCE (C(1655),RTYE)	D1	296
EQUIVALENCE (C(1656),RTZED)	D1	297
EQUIVALENCE (C(1659),RTZE)	G5	24
EQUIVALENCE (C(1659),RTZE)	D1	37
EQUIVALENCE (C(1659),RTZE)	D1	298
EQUIVALENCE (C(1660),VTXE)	D1	311
EQUIVALENCE (C(1661),VTYE)	D1	312
EQUIVALENCE (C(1662),VTZE)	D1	313
EQUIVALENCE (C(1663),VDXB)	D1	314
EQUIVALENCE (C(1664),VDYB)	D1	315
EQUIVALENCE (C(1665),RHZRO)	D1	47
EQUIVALENCE (C(1665),VDZB)	D1	316
EQUIVALENCE (C(1666),BLOSV)	D1	20
EQUIVALENCE (C(1667),RSLANT)	D1	21
EQUIVALENCE (C(1667),RSLANT)	S4	64
EQUIVALENCE (C(1668),RXO)	G5	25
EQUIVALENCE (C(1668),RXO)	D1	38
EQUIVALENCE (C(1669),RYO)	G5	26
EQUIVALENCE (C(1669),RYO)	D1	39
EQUIVALENCE (C(1670),RZO)	G5	27
EQUIVALENCE (C(1670),RZO)	D1	40
EQUIVALENCE (C(1671),VXO)	G5	28
EQUIVALENCE (C(1671),VXO)	D1	41
EQUIVALENCE (C(1672),VYO)	G5	29
EQUIVALENCE (C(1672),VYO)	D1	42
EQUIVALENCE (C(1673),VZO)	G5	30
EQUIVALENCE (C(1673),VZO)	D1	43
EQUIVALENCE (C(1674),VMWTE)	D1	22
EQUIVALENCE (C(1676),ANGX)	D1	317
EQUIVALENCE (C(1676), ANGX)	S2	331

TABLE 84. (Continued)

```
EQUIVALENCE (C(1676),   ANGX)                        S3      65
EQUIVALENCE (C(1677),ANGY  )                         D1     318
EQUIVALENCE (C(1677),ANGY)                           C1      96
EQUIVALENCE (C(1677),   ANGY)                        S2     332
EQUIVALENCE (C(1677),   ANGY)                        S3      66
EQUIVALENCE (C(1678),ANGZ  )                         D1     319
EQUIVALENCE (C(1678),ANGZ)                           C1      97
EQUIVALENCE (C(1678),   ANGZ)                        S2     333
EQUIVALENCE (C(1678),   ANGZ)                        S3      67
EQUIVALENCE (C(1680),RSJYMC)                         G5      31
EQUIVALENCE (C(1680),RSJYMC)                         SPOT     8
EQUIVALENCE (C(1680),RSJYMC)                         SPOT    54
EQUIVALENCE (C(1680),RSJYMC)                         D1      51
IF(C(1680).GT.C(1567)) C(1567) = C(1680)             IO     208
IF(C(1680).GT.C(1567)) C(1567) = C(1680)             IO     208
IF(C(1680).LT.C(1568)) C(1568) = C(1680)             IO     209
IF(C(1680).LT.C(1568)) C(1568) = C(1680)             IO     209
EQUIVALENCE (C(1681),RSJZMC)                         G5      32
EQUIVALENCE (C(1681),RSJZMC)                         SPOT     9
EQUIVALENCE (C(1681),RSJZMC)                         SPOT    55
EQUIVALENCE (C(1681),RSJZMC)                         D1      52
EQUIVALENCE (C(1681),ADIVE )                         D1     258
IF(C(1681).GT.C(1577)) C(1577) = C(1681)             IO     210
IF(C(1681).GT.C(1577)) C(1577) = C(1681)             IO     210
IF(C(1681).LT.C(1578)) C(1578) = C(1681)             IO     211
IF(C(1681).LT.C(1578)) C(1578) = C(1681)             IO     211
EQUIVALENCE (C(1682),RSPOTX)                         G5      33
EQUIVALENCE (C(1682),RSPOTX)                         SPOT    56
EQUIVALENCE (C(1683),FSPOTY)                         G5      34
EQUIVALENCE (C(1683),RSPOTY)                         SPOT    57
EQUIVALENCE (C(1684),RSPOTZ)                         G5      35
EQUIVALENCE (C(1684),RSPOTZ)                         SPOT    58
EQUIVALENCE (C(1700),CFA11D)                         D2      82
EQUIVALENCE (C(1703),CFA11 )                         G5      51
EQUIVALENCE (C(1703),CFA11 )                         D1     265
EQUIVALENCE (C(1703),CFA11 )                         D2      14
EQUIVALENCE (C(1703),CFA11 )                         D2      83
EQUIVALENCE (C(1704),CFA12D)                         D2      84
EQUIVALENCE (C(1707),CFA12 )                         G5      52
EQUIVALENCE (C(1707),CFA12 )                         D1     266
EQUIVALENCE (C(1707),CFA12 )                         D2      15
EQUIVALENCE (C(1707),CFA12 )                         D2      85
EQUIVALENCE (C(1708),CFA13D)                         D2      86
EQUIVALENCE (C(1711),CFA13 )                         G5      53
EQUIVALENCE (C(1711),CFA13 )                         D1     267
EQUIVALENCE (C(1711),CFA13 )                         D2      16
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TABLE 84. (Continued)

```
EQUIVALENCE (C(1711),CFA13 )                                    D2     87
EQUIVALENCE (C(1712),CFA21D)                                    D2     88
EQUIVALENCE (C(1715),CFA21 )                                    G5     54
EQUIVALENCE (C(1715),CFA21 )                                    D1    268
EQUIVALENCE (C(1715),CFA21 )                                    D2     17
EQUIVALENCE (C(1715),CFA21 )                                    D2     89
EQUIVALENCE (C(1716),CFA22D)                                    D2     90
EQUIVALENCE (C(1719),CFA22 )                                    G5     55
EQUIVALENCE (C(1719),CFA22 )                                    D1    269
EQUIVALENCE (C(1719),CFA22 )                                    D2     18
EQUIVALENCE (C(1719),CFA22 )                                    D2     91
EQUIVALENCE (C(1720),CFA23D)                                    D2     92
EQUIVALENCE (C(1723),CFA23 )                                    G5     56
EQUIVALENCE (C(1723),CFA23 )                                    A2     42
EQUIVALENCE (C(1723),CFA23 )                                    D1    270
EQUIVALENCE (C(1723),CFA23 )                                    D2     19
EQUIVALENCE (C(1723),CFA23 )                                    D2     93
EQUIVALENCE (C(1724),CFA31D)                                    D2     94
EQUIVALENCE (C(1727),CFA31 )                                    G5     57
EQUIVALENCE (C(1727),CFA31 )                                    D1    271
EQUIVALENCE (C(1727),CFA31 )                                    D2     20
EQUIVALENCE (C(1727),CFA31 )                                    D2     95
EQUIVALENCE (C(1728),CFA32D)                                    D2     96
EQUIVALENCE (C(1731),CFA32 )                                    G5     58
EQUIVALENCE (C(1731),CFA32 )                                    D1    272
EQUIVALENCE (C(1731),CFA32 )                                    D2     21
EQUIVALENCE (C(1731),CFA32 )                                    D2     97
EQUIVALENCE (C(1732),CFA33D)                                    D2     98
EQUIVALENCE (C(1735),CFA33 )                                    G5     59
EQUIVALENCE (C(1735),CFA33 )                                    A2     43
EQUIVALENCE (C(1735),CFA33 )                                    D1    273
EQUIVALENCE (C(1735),CFA33 )                                    D2     22
EQUIVALENCE (C(1735),CFA33 )                                    D2     99
EQUIVALENCE (C(1736),WPD    )                                   D2    100
EQUIVALENCE (C(1736),WPD)                                       C1     95
EQUIVALENCE (C(1736),     WPD)                                  S2    334
EQUIVALENCE (C(1736),     WPD)                                  S3     68
EQUIVALENCE (C(1737),     FMX), (C(1741),    FMY), (C(1745), FMZ) A3   34
EQUIVALENCE (C(1737),     FMX), (C(1741),    FMY), (C(1745), FMZ) A2   46
EQUIVALENCE (C(1738),    WPTO)                                  A2     49
EQUIVALENCE (C(1739),WP    )                                    A3     23
EQUIVALENCE (C(1739),WP    )                                    A2     44
EQUIVALENCE (C(1739),WP    )                                    D2    101
EQUIVALENCE (C(1739),WP    )                                    S1    146
EQUIVALENCE (C(1739),WP    )                                    S4    246
EQUIVALENCE (C(1739),      WP)                                  S2    325
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TABLE 84. (Continued)

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EQUIVALENCE (C(1739),     WP)                                   S3    59
EQUIVALENCE (C(1740),WQD   )                                    D2   102
EQUIVALENCE (C(1740),    WQD)                                   S2   335
EQUIVALENCE (C(1740),    WQD)                                   S3    69
EQUIVALENCE (C(1737),     FMX),  (C(1741),    FMY), (C(1745), FMZ) A3    34
EQUIVALENCE (C(1737),     FMX),  (C(1741),    FMY), (C(1745), FMZ) A2    46
CALL LIRAN(T,DELT,C(1742),DUM,WQ0,IFLG1,2)                      A3    67
EQUIVALENCE (C(1742),    AMP2),  (C(1746),   AMP1)              A2    13
EQUIVALENCE (C(1743),WQ    )                                    A3    24
EQUIVALENCE (C(1743),WQ    )                                    A2    45
EQUIVALENCE (C(1743),WQ    )                                    D2   103
EQUIVALENCE (C(1743),WQ    )                                    S1   147
EQUIVALENCE (C(1743),WQ    )                                    S4   247
EQUIVALENCE (C(1743),WQ    )                                    C1   109
EQUIVALENCE (C(1743),     WQ)                                   S2   326
EQUIVALENCE (C(1743),     WQ)                                   S3    60
EQUIVALENCE (C(1744),WRD   )                                    D2   104
EQUIVALENCE (C(1744),    WRD)                                   S2   336
EQUIVALENCE (C(1744),    WRD)                                   S3    70
EQUIVALENCE (C(1737),     FMX),  (C(1741),    FMY), (C(1745), FMZ) A3    34
EQUIVALENCE (C(1737),     FMX),  (C(1741),    FMY), (C(1745), FMZ) A2    46
CALL LIRAN(T,DELT,C(1746),DUM,WR0,IFLG2,1)                      A3    66
EQUIVALENCE (C(1742),    AMP2),  (C(1746),   AMP1)              A2    13
EQUIVALENCE (C(1747),WR    )                                    A3    25
EQUIVALENCE (C(1747),WR    )                                    A2    47
EQUIVALENCE (C(1747),WR    )                                    D2   105
EQUIVALENCE (C(1747),WR    )                                    S1   148
EQUIVALENCE (C(1747),WR    )                                    S4   248
EQUIVALENCE (C(1747),WR    )                                    C1   110
EQUIVALENCE (C(1747),     WR)                                   S2   327
EQUIVALENCE (C(1747),     WR)                                   S3    61
EQUIVALENCE (C(1748),FMIX  )                                    A3    26
EQUIVALENCE (C(1748),FMIX  )                                    A3   128
EQUIVALENCE (C(1748),    FMIX)                                  A2    48
EQUIVALENCE (C(1748),FMIX  )                                    A2    65
EQUIVALENCE (C(1748),FMIX  )                                    D2    70
EQUIVALENCE (C(1749),FMIY  )                                    A3    27
EQUIVALENCE (C(1749),FMIY  )                                    A3   129
EQUIVALENCE (C(1749),FMIY  )                                    A2    66
EQUIVALENCE (C(1749),FMIY  )                                    D2    71
EQUIVALENCE (C(1750),FMIZ  )                                    A3    28
EQUIVALENCE (C(1750),FMIZ  )                                    A3   130
EQUIVALENCE (C(1750),FMIZ  )                                    A2    67
EQUIVALENCE (C(1750),FMIZ )                                     D2    72
EQUIVALENCE (C(1751),CRAD  )                                    G5    60
EQUIVALENCE (C(1751),    CRAD)                                  A3    32
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TABLE 84. (Continued)

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EQUIVALENCE (C(1751),   CRAD)        A2         50
EQUIVALENCE (C(1751),CRAD  )         D1         23
EQUIVALENCE (C(1751),CRAD  )         D1        259
EQUIVALENCE (C(1751),CRAD  )         D2         73
EQUIVALENCE (C(1751),   CRAD)        S2         56
EQUIVALENCE (C(1751),   CRAD)        S2        328
EQUIVALENCE (C(1751),   CRAD)        S3         62
EQUIVALENCE (C(1752),BPHIO )         D1         44
EQUIVALENCE (C(1752),BPHIO )         D2          7
EQUIVALENCE (C(1753),BTHTO )         D1         45
EQUIVALENCE (C(1753),BTHTO )         D2          8
EQUIVALENCE (C(1754),BPSIO )         D1         46
EQUIVALENCE (C(1754),BPSIO )         D2          9
EQUIVALENCE (C(1755),A021  )         G5         74
EQUIVALENCE (C(1755),  A021)         D1         57
EQUIVALENCE (C(1755),A021  )         D2         24
EQUIVALENCE (C(1756),A022  )         G5         75
EQUIVALENCE (C(1756),  A022)         D1         58
EQUIVALENCE (C(1756),A022  )         D2         25
EQUIVALENCE (C(1757),A023  )         G5         76
EQUIVALENCE (C(1757),  A023)         D1         59
EQUIVALENCE (C(1757),A023  )         D2         26
EQUIVALENCE (C(1758),A031  )         G5         77
EQUIVALENCE (C(1758),  A031)         D1         60
EQUIVALENCE (C(1758),A031  )         D2         27
EQUIVALENCE (C(1759),A032  )         G5         78
EQUIVALENCE (C(1759),  A032)         D1         61
EQUIVALENCE (C(1759),A032  )         D2         28
EQUIVALENCE (C(1760),A033  )         G5         79
EQUIVALENCE (C(1760),  A033)         D1         62
EQUIVALENCE (C(1760),A033  )         D2         29
EQUIVALENCE (C(1761),  A011)         G5         71
EQUIVALENCE (C(1761),  A011)         D1         54
EQUIVALENCE (C(1762),  A012)         G5         72
EQUIVALENCE (C(1762),  A012)         D1         55
EQUIVALENCE (C(1763),  A013)         G5         73
EQUIVALENCE (C(1763),  A013)         D1         56
EQUIVALENCE (C(1764),    P1)         G5         67
EQUIVALENCE (C(1764),    P1)         D1         63
EQUIVALENCE (C(1765),R1)             ROLLGYRO    1
EQUIVALENCE (C(1765),R1)             ROLLGYRO   14
EQUIVALENCE (C(1768),  XB01)         G5         61
EQUIVALENCE (C(1768),  XB01)         D1         67
EQUIVALENCE (C(1769),  YB01)         G5         62
EQUIVALENCE (C(1769),  YB01)         D1         68
EQUIVALENCE (C(1770),  ZB01)         G5         63
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TABLE 84. (Continued)

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EQUIVALENCE (C(1770), ZB01)                                              D1       69
EQUIVALENCE (C(1771), XB02)                                              G5       64
EQUIVALENCE (C(1771), XB02)                                              D1       70
EQUIVALENCE (C(1772), YB02)                                              G5       65
EQUIVALENCE (C(1772), YB02)                                              D1       71
EQUIVALENCE (C(1773), ZB02)                                              G5       66
EQUIVALENCE (C(1773), ZB02)                                              D1       72
EQUIVALENCE (C(1901),ISCALE),(C(1916),YMAX),(C(1931),YMIN)               MC7      44
EQUIVALENCE (C(1901),ISCALE),(C(1916),YMAX),(C(1931),YMIN)               IO       29
EQUIVALENCE (C(1901),ISCALE),(C(1916),YMAX),(C(1931),YMIN)               MC7      44
EQUIVALENCE (C(1901),ISCALE),(C(1916),YMAX),(C(1931),YMIN)               IO       29
EQUIVALENCE (C(1901),ISCALE),(C(1916),YMAX),(C(1931),YMIN)               MC7      44
EQUIVALENCE (C(1901),ISCALE),(C(1916),YMAX),(C(1931),YMIN)               IO       29
EQUIVALENCE             (C(1971),RITE  ), (C(1972),RKUTTA)               MC7      17
EQUIVALENCE             (C(1971),RITE  ), (C(1972),RKUTTA)               MC7      17
EQUIVALENCE  (C(1972),RKUTTA)                                            A2       53
EQUIVALENCE (C(1973),KASE  ), (C(1974),NJ    ), (C(1975),NPT   )         MC7      18
EQUIVALENCE (C(1973),KASE  ), (C(1974),NJ    ), (C(1975),NPT   )         EXEC     93
EQUIVALENCE (C(1973),KASE  ), (C(1974),NJ    ), (C(1975),NPT   )         MC7      18
EQUIVALENCE (C(1974),     NJ)                                            AMRK      8
EQUIVALENCE (C(1973),KASE  ), (C(1974),NJ    ), (C(1975),NPT   )         EXEC     93
EQUIVALENCE (C(1973),KASE  ), (C(1974),NJ    ), (C(1975),NPT   )         MC7      18
EQUIVALENCE (C(1975),NPT)                                                A2       54
EQUIVALENCE (C(1973),KASE  ), (C(1974),NJ    ), (C(1975),NPT   )         EXEC     93
C(1976) = 1.                                                             MC7      86
C(1976)=1.                                                               MC7     110
IF(C(1976).LE.0.) GO TO 1000                                             MCARLO  127
IF(C(1976).LE.0.) GO TO 20                                               G5      157
IF(C(1976).LE.0.) GO TO 82                                               S1      210
IF(C(1976).LE.0.) GO TO 82                                               S4      357
IF(C(1976).LT.0)RETURN                                                   C3       59
EQUIVALENCE (C(1976),XNDRK)                                              AMRK     10
IF(C(1976).LE.0.)GO TO 32                                                S2      425
IF(TIME.LT.(TDELAY-.00001).OR.C(1976).LE.0.)GO TO 30                     S2      447
IF(C(1976).LE.0.)GO TO 32                                                S3      153
IF(TIME.LT.(TDELAY-.00001).OR.C(1976).LE.0.)GO TO 30                     S3      171
EQUIVALENCE (C(1980),RN    )                                             MC7      49
EQUIVALENCE (C(1981),RNT   )                                             MC7      50
EQUIVALENCE (C(1982),PLOTN4)                                             MC7      51
EQUIVALENCE (C(1983),PLOTN2)                                             MC7      52
EQUIVALENCE (C(1984),NPLOT )                                             MC7      53
EQUIVALENCE (C(1984),NPLOT )                                             IO       12
EQUIVALENCE (C(1984),NPLOT )                                             IO      254
EQUIVALENCE (C(1985),OUTPLT)                                             IO       13
EQUIVALENCE (C(1985),OUTPLT)                                             IO      168
EQUIVALENCE (C(1985),OUTPLT)                                             IO      198
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TABLE 84. (Continued)

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C             (C(2000),T      ), (C(2011),KSTEP ), (C(2010),STEP  ),  MC7        12
 EQUIVALENCE (C(2000),       T)                                       MCARLO      7
 IF(C(2000).LT.TNXST(ITSNDX)) GO TO 1000                              MCARLO    128
 TNXST(IB)=C(2000)+ TSPER(IB)                                         MCARLO    144
 EQUIVALENCE(C(2000),T)                                               G2         53
 EQUIVALENCE (C(2000),T      )                                        G5         80
 EQUIVALENCE (C(2000),T      )                                        A1         22
 EQUIVALENCE (C(2000),       T)                                       A3         29
 EQUIVALENCE (C(2000),T      )                                        A3        114
 EQUIVALENCE (C(2000),T      )                                        A2         52
 EQUIVALENCE (C(2000),T      )                                        D1        274
 EQUIVALENCE (C(2000),T      )                                        S1        113
 EQUIVALENCE (C(2000),T      )                                        S4        208
 EQUIVALENCE (C(2000),T      )                                        C1        112
 EQUIVALENCE (C(2000),T  )                                            C3         45
 WRITE(6,14)C(2000),XIN,I,J                                           C3        170
 WRITE(6,14)C(2000),XIN,J                                             C3        190
 WRITE(6,14)C(2000),XIN,J                                             C3        206
 EQUIVALENCE (C(2000),T      )                                        G4         19
 EQUIVALENCE (C(2000),      T)                                        AMRK        6
 EQUIVALENCE (C(2000),T      ), (C(2361),NOMOD ), (C(2362),XMODNO)    AMRK      135
C             (C(2000),T      ), (C(2021),KCONV ), (C(2025),TIME  ),  IO        162
C             (C(2000),T      ), (C(2664),DER   ), (C(2018),TAPE  ),  IO        194
 EQUIVALENCE (C(2000),T      ), (C(2001),TF    ), (C(2003),PCNT  )    EXEC       88
 WRITE (6,30) C(2000),C(367),C(368),C(204),C(369),C(370),C(1117),     EXEC      282
 C(655)=C(2000)-C(2664)                                               S2        180
 EQUIVALENCE (C(2000),    TIME)                                       S2        329
 EQUIVALENCE (C(2000),    TIME)                                       S3         63
 EQUIVALENCE (C(2000),T      ), (C(2001),TF    ), (C(2003),PCNT  )    EXEC       88
 OPOINT = 0   $ PPNT=C(2002)                                          IO        181
C             (C(2014),ITCNT ), (C(2003),PCNT  ), (C(2015),CPP   ),   IO        160
C             (C(2014),ITCNT ), (C(2003),PCNT  ), (C(2015),CPP   ),   IO        193
 EQUIVALENCE (C(2000),T      ), (C(2001),TF    ), (C(2003),PCNT  )    EXEC       88
C             (C(2004),PPNT  ), (C(2023),OPOINT)                      IO        164
C             (C(2005),PPP   ), (C(2004),PPNT  ), (C(2025),TIME  ),   IO        196
C             (C(2005),PPP   ), (C(2004),PPNT  ), (C(2025),TIME  ),   IO        196
C             (C(3167),NOOUT ), (C(2022),OPTN10), (C(2006),REPPLT),   MC7        15
C             (C(2865),EU    ), (C(2765),EL    ), (C(2007),PTLESS)    MC7        16
C             (C(2012),LSTEP ), (C(2008),PLOTNO), (C(2009),NOPLOT),   MC7        13
C             (C(3067),LISTNO), (C(3117),VALUE ), (C(2008),PLOTNO),   IO          9
C             (C(2008),PLOTNO), (C(2009),NOPLOT), (C(3168),OUTNO ),   IO        163
C             (C(2019),TAPEND), (C(2008),PLOTNO), (C(2009),NOPLOT),   IO        195
C             (C(2012),LSTEP ), (C(2008),PLOTNO), (C(2009),NOPLOT),   MC7        13
C             (C(2009),NOPLOT), (C(2325),VLABLE), (C,K)               IO         10
C             (C(2008),PLOTNO), (C(2009),NOPLOT), (C(3168),OUTNO ),   IO        163
C             (C(2019),TAPEND), (C(2008),PLOTNO), (C(2009),NOPLOT),   IO        195
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TABLE 84. (Continued)

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C              (C(2000),T      ), (C(2011),KSTEP ), (C(2010),STEP  ),  MC7     12
 EQUIVALENCE   (C(2010),  STEP)                                        IO      11
 EQUIVALENCE   (C(2010),STEP   ), (C(2011),KSTEP ), (C(2020),LCONV )   EXEC    89
C              (C(2000),T      ), (C(2011),KSTEP ), (C(2010),STEP  ),  MC7     12
 EQUIVALENCE(C(2011),KSTEP)                                            S1      15
 EQUIVALENCE   (C(2011), KSTEP)                                        S4      75
 EQUIVALENCE   (C(2011),KSTEP ), (C(2020),LCONV ), (C(2021),KCONV )    EXEC    80
 EQUIVALENCE   (C(2010),STEP  ), (C(2011),KSTEP ), (C(2020),LCONV )    EXEC    89
C              (C(2012),LSTEP ), (C(2008),PLOTNO), (C(2009),NOPLOT),   MC7     13
C              (C(2018),TAPE  ), (C(2019),TAPEND), (C(2013),DOC    ),  IO     161
C              (C(2014),ITCNT ), (C(2003),PCNT  ), (C(2015),CPP    ),  IO     160
C              (C(2014),ITCNT ), (C(2003),PCNT  ), (C(2015),CPP    ),  IO     193
C              (C(2014),ITCNT ), (C(2003),PCNT  ), (C(2015),CPP    ),  IO     160
C              (C(2014),ITCNT ), (C(2003),PCNT  ), (C(2015),CPP    ),  IO     193
 EQUIVALENCE   (C(2017),DTCNT ), (C(3167),NOOUT ), (C(2016),PGCNT ),   IO     159
C              (C(2017),DTCNT ), (C(3167),NOOUT ), (C(2016),PGCNT ),   IO     192
 EQUIVALENCE   (C(2017),DTCNT ), (C(3167),NOOUT ), (C(2016),PGCNT ),   IO     159
C              (C(2017),DTCNT ), (C(3167),NOOUT ), (C(2016),PGCNT ),   IO     192
C              (C(2018),TAPE  ), (C(2019),TAPEND), (C(2013),DOC    ),  IO     161
C              (C(2000),T     ), (C(2664),DER   ), (C(2018),TAPE   ),  IO     194
C              (C(2018),TAPE  ), (C(2019),TAPEND), (C(2013),DOC    ),  IO     161
C              (C(2019),TAPEND), (C(2008),PLOTNO), (C(2009),NOPLOT),   IO     195
*,             (C(2020),LCONV )                                        G4      24
 EQUIVALENCE   (C(2020),LCONV)                                         AMRK   138
 EQUIVALENCE   (C(2011),KSTEP ), (C(2020),LCONV ), (C(2021),KCONV )    EXEC    80
 EQUIVALENCE   (C(2010),STEP  ), (C(2011),KSTEP ), (C(2020),LCONV )    EXEC    89
 EQUIVALENCE   (C(2020),LCONV)                                         EXEC   266
 EQUIVALENCE   (C(2020),LCONV)                                         EXEC   274
 EQUIVALENCE   (C(2020),  LCONV), (C( 625),    IBL)                    S2     370
 EQUIVALENCE   (C(2020),  LCONV), (C( 625),    IBL)                    S3      98
C              (C(2000),T     ), (C(2021),KCONV ), (C(2025),TIME  ),   IO     162
 EQUIVALENCE   (C(2011),KSTEP ), (C(2020),LCONV ), (C(2021),KCONV )    EXEC    80
 EQUIVALENCE   (C(2021),KCONV ), (C(2561),N     ), (C(2662),HMIN  )    EXEC    90
C              (C(3167),NOOUT ), (C(2022),OPTN10), (C(2006),REPPLT),   MC7     15
C              (C(2023),OPOINT), (C(2025),TIME  ), (C(2325),VLABLE),   MC7     14
C              (C(2004),PPNT  ), (C(2023),OPOINT)                      IO     164
C              (C(2023),OPOINT)                                        IO     197
 EQUIVALENCE   (C(2023),OPOINT)                                        IO     255
C              (C(2023),OPOINT), (C(2025),TIME  ), (C(2325),VLABLE),   MC7     14
C              (C(2000),T     ), (C(2021),KCONV ), (C(2025),TIME  ),   IO     162
C              (C(2005),PPP   ), (C(2004),PPNT  ), (C(2025),TIME  ),   IO     196
C              (C(2023),OPOINT), (C(2025),TIME  ), (C(2325),VLABLE),   MC7     14
C              (C(2009),NOPLOT), (C(2325),VLARLE), (C,K)               IO      10
 EQUIVALENCE   (C(2361),NOMOD ), (C(2362),XMODNO), (C(2561),N     )    AMRK    50
 EQUIVALENCE   (C(2000),T     ), (C(2361),NOMOD ), (C(2362),XMODNO)    AMRK   135
C              (C(3328),ONAME4), (C(2361),NOMOD ), (C(2362),MODNO ),   IO       6
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TABLE 84. (Continued)

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 EQUIVALENCE (C(2361),NOMOD )                                      IO      256
 EQUIVALENCE (C(2361),NOMOD ), (C(2362),XMODNO), (C(2561),N     )  AMRK     50
 EQUIVALENCE (C(2000),T     ), (C(2361),NOMOD ), (C(2362),XMODNO)  AMRK    135
C            (C(3328),ONAME4), (C(2361),NOMOD ), (C(2362),MODNO ), IO        6
C            (C(3168),OUTNO ), (C(2461),NOSUB ), (C(2462),SUBNO ), IO        7
 EQUIVALENCE (C(2461),NOSUB )                                      IO      257
 EQUIVALENCE (C(2461),NOSUB ), (C(2462),SUBNO )                    EXEC      4
 EQUIVALENCE (C(2461),NOSUB ), (C(2462),SUBNO )                    EXEC     30
 EQUIVALENCE (C(2461),NOSUB ), (C(2462),SUBNO )                    EXEC     55
C            (C(3168),OUTNO ), (C(2461),NOSUB ), (C(2462),SUBNO ), IO        7
 EQUIVALENCE (C(2461),NOSUB ), (C(2462),SUBNO )                    EXEC      4
 EQUIVALENCE (C(2461),NOSUB ), (C(2462),SUBNO )                    EXEC     30
 EQUIVALENCE (C(2461),NOSUB ), (C(2462),SUBNO )                    EXEC     55
C            (C(2561),N     ), (C(2562),IPL   ), (C(2965),VAR   ), MC7      11
 EQUIVALENCE (C(2561),     N)                                      G2       72
 EQUIVALENCE (C(2561),N     )                                      SPOT      4
 EQUIVALENCE (C(2561),N     )                                      A3       30
 EQUIVALENCE (C(2561),N     )                                      D1        5
 EQUIVALENCE (C(2561),N      )                                     D2       11
 EQUIVALENCE (C(2561),N)                                           S1       26
 EQUIVALENCE (C(2561),N)                                           S4       66
 EQUIVALENCE (C(2561),N     )                                      C1       10
 EQUIVALENCE (C(2561),N     )                                      C4       30
 EQUIVALENCE (C(2561),N)                                           C5       22
 EQUIVALENCE (C(2361),NOMOD ), (C(2362),XMODNO), (C(2561),N     )  AMRK     50
 EQUIVALENCE (C(2561),N     ), (C(2562),IPL   ), (C(2664),DER   )  AMRK    136
 EQUIVALENCE (C(2021),KCONV ), (C(2561),N     ), (C(2662),HMIN  )  EXEC     90
 EQUIVALENCE (C(2561),     N),  (C(2562),    IPL)                  S2       84
C            (C(2561),N     ), (C(2562),IPL   ), (C(2965),VAR   ), MC7      11
 EQUIVALENCE (C(2562),   IPL)                                      G2       73
 EQUIVALENCE (C(2562),IPL   )                                      SPOT      5
 EQUIVALENCE (C(2562),IPL   )                                      A3       31
 EQUIVALENCE (C(2562),IPL   )                                      D1        6
 EQUIVALENCE (C(2562),IPL    )                                     D2       12
 EQUIVALENCE (C(2562),IPL)                                         S1       27
 EQUIVALENCE (C(2562),IPL)                                         S4       67
 EQUIVALENCE (C(2562),IPL   )                                      C1       11
 EQUIVALENCE (C(2562),IPL   )                                      C4       31
 EQUIVALENCE (C(2562),IPL)                                         C5       23
 EQUIVALENCE (C(2562),   IPL)                                      AMRK      9
 EQUIVALENCE (C(2561),N     ), (C(2562),IPL   ), (C(2664),DER   )  AMRK    136
 EQUIVALENCE (C(2561),     N),  (C(2562),    IPL)                  S2       84
 EQUIVALENCE (C(2662),HMIN  ), (C(2663),HMAX  ), (C(2664),DER   ), MC7      10
 EQUIVALENCE (C(2662)   ,DERSV)                                    MC7      34
 EQUIVALENCE (C(2662)   ,DERSV)                                    S1       29
 EQUIVALENCE (C(2662),DERSV )                                      S4       68
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TABLE 84. (Continued)

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 EQUIVALENCE (C(2965),VAR   )                                      AMRK   137
 EQUIVALENCE (C(2865),EU    ), (C(2965),VAR   )                    EXEC    92
 EQUIVALENCE (C(3000),VSD   )                                      MC7     35
 EQUIVALENCE (C(3000),VSD   )                                      G4      31
 EQUIVALENCE (C(3010),VMEAN )                                      MC7     36
 EQUIVALENCE (C(3010),VMEAN )                                      G4      32
 EQUIVALENCE (C(3020),IMVNDX)                                      MC7     37
 EQUIVALENCE (C(3020),IMVNDX)                                      G4      33
 EQUIVALENCE (C(3020),IMVNDX)                                      IO      26
 EQUIVALENCE (C(3030),IMVCT )                                      MC7     38
 EQUIVALENCE (C(3030),IMVCT )                                      G4      34
 EQUIVALENCE (C(3030),IMVCT )                                      IO      27
 EQUIVALENCE (C(3066),NOLIST)                                      IO     258
 EQUIVALENCE (C(3066),NOLIST), (C(3067),LISTNO), (C(3117),VALUE )  EXEC   121
C            (C(3067),LISTNO), (C(3117),VALUE ), (C(2008),PLOTNO), IO       9
 EQUIVALENCE (C(3066),NOLIST), (C(3067),LISTNO), (C(3117),VALUE )  EXEC   121
C            (C(3067),LISTNO), (C(3117),VALUE ), (C(2008),PLOTNO), IO       9
 EQUIVALENCE (C(3066),NOLIST), (C(3067),LISTNO), (C(3117),VALUE )  EXEC   121
C            (C(3167),NOOUT ), (C(2022),OPTN10), (C(2006),REPPLT), MC7     15
 EQUIVALENCE (C(2017),DTCNT ), (C(3167),NOOUT ), (C(2016),PGCNT ), IO     159
C            (C(2017),DTCNT ), (C(3167),NOOUT ), (C(2016),PGCNT ), IO     192
 EQUIVALENCE (C(3167),NOOUT )                                      IO     259
C            (C(3168),OUTNO ), (C(2461),NOSUB ), (C(2462),SUBNO ), IO       7
C            (C(2008),PLOTNO), (C(2009),NOPLOT), (C(3168),OUTNO ), IO     163
 EQUIVALENCE (C(3168),OUTNO ), (C(3218),ONAME1), (C(3268),ONAME2), IO     191
 EQUIVALENCE (C(3218),ONAME1), (C(3268),ONAME2), (C(3318),ONAME3), IO       5
 EQUIVALENCE (C(3168),OUTNO ), (C(3218),ONAME1), (C(3268),ONAME2), IO     191
 EQUIVALENCE (C(3218),ONAME1), (C(3268),ONAME2), (C(3318),ONAME3), IO       5
 EQUIVALENCE (C(3168),OUTNO ), (C(3218),ONAME1), (C(3268),ONAME2), IO     191
 EQUIVALENCE (C(3218),ONAME1), (C(3268),ONAME2), (C(3318),ONAME3), IO       5
C            (C(3328),ONAME4), (C(2361),NUMOD ), (C(2362),MODNO ), IO       6
 EQUIVALENCE (C(3338),X1)                                          C3     110
 EQUIVALENCE (C(3345),X2)                                          C3     111
 EQUIVALENCE (C(3352),X3)                                          C3     112
 EQUIVALENCE (C(3359),A0)                                          C3     113
 EQUIVALENCE (C(3359),COEFF)                                       IO      48
 EQUIVALENCE (C(3363),A1)                                          C3     114
 EQUIVALENCE (C(3367),A2)                                          C3     115
 EQUIVALENCE (C(3371),A3)                                          C3     116
 EQUIVALENCE (C(3375),B1)                                          C3     117
 EQUIVALENCE (C(3379),B2)                                          C3     118
 EQUIVALENCE (C(3383),B3)                                          C3     119
 EQUIVALENCE (C(3387),REF(1,1))                                    C3     158
 EQUIVALENCE (C(3387),REF)                                         IO      49
 EQUIVALENCE (C(3415),BIT(1,1))                                    C3     159
 EQUIVALENCE (C(3415),BREF)                                        IO      50
```

TABLE 84. (Continued)

```
      EQUIVALENCE (C(2021),KCONV ), (C(2561),N      ), (C(2662),HMIN  )   EXEC      90
      EQUIVALENCE (C(2662)  ,DERSV)                                       S2        85
      EQUIVALENCE (C(2662),HMIN  ), (C(2663),HMAX  ), (C(2664),DER   ),   MC7       10
      EQUIVALENCE (C(2663),HMAX  ), (C(2664),DER   ), (C(2765),EL    )    EXEC      91
      EQUIVALENCE (C(2662),HMIN  ), (C(2663),HMAX  ), (C(2664),DER   ),   MC7       10
      EQUIVALENCE (C(2664),      DT)                                      MCARLO    12
      GSIGU = SIGU*SQRT(1.89/C(2664))                                     G2       103
     1  GSPOTY = .707*SIGSPOT/SQRT(W0/4./ZETA * C(2664))                  SPOT      37
     1  GSPOTZ = .707*SIGSPOT/SQRT(W0/4./ZETA * C(2664))                  SPOT      44
      EQUIVALENCE (C(2664),DER   )                                        A1        23
     1  GSPOTY = .707*SIGSPOT/SQRT(W0/4./ZETA * C(2664))                  D1       103
     1  GSPOTZ = .707*SIGSPOT/SQRT(W0/4./ZETA * C(2664))                  D1       110
      C(2664) = DT / AINT(DT / C(2764))                                   S1       215
      C(2664) = DT / AINT(DT / C(2764))                                   S4       362
      IF(C(2664)-0.01 .LT. 1.E-6)GO TO 10                                 C3         4
       C(2664)=0.01                                                       C3         6
   30 IF(ABS(0.01-C(2664)*AINT(0.01/C(2664)+1.E-6)).LT.1.E-6)GO TO 50     C3        13
   30 IF(ABS(0.01-C(2664)*AINT(0.01/C(2664)+1.E-6)).LT.1.E-6)GO TO 50     C3        13
      C(2664)=0.01/AINT(0.01/C(2664)+1.E-6)                               C3        14
      C(2664)=0.01/AINT(0.01/C(2664)+1.E-6)                               C3        14
      WRITE(6,45)C(2664)                                                  C3        15
      EQUIVALENCE(C(2664),DER)                                            C3        29
      EQUIVALENCE (C(2664), DELT)                                         AMRK       7
      EQUIVALENCE (C(2561),N      ), (C(2562),IPL   ), (C(2664),DER   )   AMRK     136
     C            (C(2000),T      ), (C(2664),DER   ), (C(2018),TAPE  ),  IO       194
      EQUIVALENCE (C(2663),HMAX  ), (C(2664),DER   ), (C(2765),EL    )    EXEC      91
      IF(C(2664).GT..0005)WRITE(6,112)                                    S2       127
      C(655)=C(2000)-C(2664)                                              S2       180
      C(2664)=TAU/AINT(TAU/C(2764))                                       S2       388
      C(2664)=TAU/AINT(TAU/C(2764))                                       S3       116
      C(2664) = DT / AINT(DT / C(2764))                                   S1       215
      C(2664) = DT / AINT(DT / C(2764))                                   S4       362
      C(2664)=TAU/AINT(TAU/C(2764))                                       S2       388
      C(2664)=TAU/AINT(TAU/C(2764))                                       S3       116
     C            (C(2865),EU     ), (C(2765),EL     ), (C(2007),PTLESS)  MC7       16
      EQUIVALENCE (C(2765),     NTM)                                      MCARLO    13
      EQUIVALENCE (C(2663),HMAX  ), (C(2664),DER   ), (C(2765),EL    )    EXEC      91
      EQUIVALENCE (C(2775),      TM)                                      MCARLO    14
      EQUIVALENCE (C(2785),  TRMS2)                                       MCARLO    15
      EQUIVALENCE (C(2795),   TRMS)                                       MCARLO    16
      EQUIVALENCE (C(2805),     TMU)                                      MCARLO    17
      EQUIVALENCE (C(2815),     TVM)                                      MCARLO    18
      EQUIVALENCE (C(2825),    TSIG)                                      MCARLO    19
     C            (C(2865),EU     ), (C(2765),EL     ), (C(2007),PTLESS)  MC7       16
      EQUIVALENCE (C(2865),EU     ), (C(2965),VAR   )                     EXEC      92
     C            (C(2561),N      ), (C(2562),IPL   ), (C(2965),VAR   ),  MC7       11
```

TABLE 84. (Continued)

```
EQUIVALENCE (C(3443),REF)                                           C3       179
EQUIVALENCE (C(3443),ATD)                                           IO        51
EQUIVALENCE (C(3448),BIT)                                           C3       180
EQUIVALENCE (C(3448),BATD)                                          IO        52
EQUIVALENCE (C(3453),REF)                                           C3       199
EQUIVALENCE (C(3453),DTA)                                           IO        53
EQUIVALENCE (C(3457),BIT)                                           C3       200
EQUIVALENCE (C(3457),BDTA)                                          IO        54
C(3462)=0.0                                                         C3        19
EQUIVALENCE(C(3462),HOLD)                                           C3        30
EQUIVALENCE (C(3502),OPTN2 )                                        D1        24
EQUIVALENCE (C(3503),OPTN3)                                         D2        74
EQUIVALENCE (C(3504),OPTN4)                                         A2        73
EQUIVALENCE (C(3504),OPTN4 )                                        D1        25
EQUIVALENCE (C(3504),OPTN4)                                         S1        28
EQUIVALENCE (C(3504),OPTN4 )                                        S4        65
EQUIVALENCE (C(3504),OPTN4 )                                        C1        92
EQUIVALENCE (C(3504),  OPTN4)                                       S2        86
EQUIVALENCE (C(3506),OPTN6 )                                        D1        26
EQUIVALENCE (C(3512),ISGCT),(C(3721),ITCT),(C(3511),RNSTRT)         MC7       19
EQUIVALENCE (C(3511),RANSTT)                                        MCARLO    26
EQUIVALENCE (C(3511),RANSTT)                                        S4       253
*(C(3594),SIGUB),(C(3634),ISNDX),(C(3674),IDIST),(C(3511),RNSTRT)   IO        15
EQUIVALENCE (C(3512),ISGCT),(C(3721),ITCT),(C(3511),RNSTRT)         MC7       19
EQUIVALENCE (C(3512), ISGCT)                                        MCARLO    20
EQUIVALENCE (C(3512), I3512)                                        G2        75
EQUIVALENCE (C(3634), ISNDX), (C(3512), I3512)                      SPOT       7
EQUIVALENCE (C(3634), ISNDX), (C(3512), I3512)                      A3         6
EQUIVALENCE (C(3634),  ISNDX),  (C(3512),  I3512)                   A2        20
EQUIVALENCE (C(3634), ISNDX), (C(3512), I3512)                      D1         8
EQUIVALENCE (C(3634), ISNDX), (C(3512), I3512)                      S1         6
EQUIVALENCE (C(3634), ISNDX), (C(3512), I3512)                      S4        69
EQUIVALENCE (C(3634),ISNDX),(C(3512),I3512)                         C1         8
EQUIVALENCE (C(3634), ISNDX), (C(3512), I3512)                      C4        11
EQUIVALENCE (C(3512),ISGCT),(C(3514),SIGMA),(C(3554),SIGLB),        IO        14
EQUIVALENCE (C(3634),  ISNDX),  (C(3512),  I3512)                   S2        90
EQUIVALENCE (C(3634),  ISNDX),  (C(3512),  I3512)                   S2       375
EQUIVALENCE (C(3634),  ISNDX),  (C(3512),  I3512)                   S3       103
EQUIVALENCE (C(3514), SIGMA)                                        MCARLO    21
EQUIVALENCE (C(3514),  SIGMA)                                       S4        72
EQUIVALENCE (C(3512),ISGCT),(C(3514),SIGMA),(C(3554),SIGLB),        IO        14
EQUIVALENCE (C(3554), SIGLB)                                        MCARLO    22
EQUIVALENCE (C(3554),  SIGLB)                                       S4        73
EQUIVALENCE (C(3512),ISGCT),(C(3514),SIGMA),(C(3554),SIGLB),        IO        14
EQUIVALENCE (C(3594), SIGUB)                                        MCARLO    23
EQUIVALENCE (C(3594),  SIGUB)                                       S4        74
```

TABLE 84. (Continued)

*(C(3594),SIGUB),(C(3634),ISNDX),(C(3674),IDIST),(C(3511),RNSTRT)	IO	15
EQUIVALENCE (C(3634), ISNDX)	MCARLO	24
EQUIVALENCE (C(3634), ISNDX)	G2	74
EQUIVALENCE (C(3634), ISNDX), (C(3512), I3512)	SPOT	7
EQUIVALENCE (C(3634), ISNDX), (C(3512), I3512)	A3	6
EQUIVALENCE (C(3634), ISNDX), (C(3512), I3512)	A2	20
EQUIVALENCE (C(3634), ISNDX), (C(3512), I3512)	D1	8
EQUIVALENCE (C(3634), ISNDX), (C(3512), I3512)	S1	6
EQUIVALENCE (C(3634), ISNDX), (C(3512), I3512)	S4	69
EQUIVALENCE (C(3634),ISNDX),(C(3512),I3512)	C1	8
EQUIVALENCE (C(3634), ISNDX), (C(3512), I3512)	C4	11
*(C(3594),SIGUB),(C(3634),ISNDX),(C(3674),IDIST),(C(3511),RNSTRT)	IO	15
EQUIVALENCE (C(3634), ISNDX), (C(3512), I3512)	S2	90
EQUIVALENCE (C(3634), ISNDX), (C(3512), I3512)	S2	375
EQUIVALENCE (C(3634), ISNDX), (C(3512), I3512)	S3	103
EQUIVALENCE (C(3674), IDIST)	MCARLO	25
*(C(3594),SIGUB),(C(3634),ISNDX),(C(3674),IDIST),(C(3511),RNSTRT)	IO	15
EQUIVALENCE (C(3512),ISGCT),(C(3721),ITCT),(C(3511),RNSTRT)	MC7	19
EQUIVALENCE (C(3721), ITCT)	MCARLO	27
EQUIVALENCE (C(3721),ITCT)	G2	6
EQUIVALENCE (C(3721), ITCT)	G2	77
EQUIVALENCE (C(3721), ITCT)	G5	37
EQUIVALENCE (C(3753),ITNDX),(C(3721),ITCT)	SPOT	10
EQUIVALENCE (C(3721), ITCT)	SPOT	60
EQUIVALENCE (C(3753),ITNDX),(C(3721),ITCT)	D1	53
EQUIVALENCE (C(3721), ITCT)	S4	71
EQUIVALENCE (C(3721), ITCT)	S4	237
EQUIVALENCE (C(3721), ITCT)	G4	30
EQUIVALENCE(C(3721),ITCT),(C(3723),TSGMA),(C(3733),TLB),	IO	16
EQUIVALENCE (C(3723), TSGMA)	MCARLO	28
EQUIVALENCE(C(3721),ITCT),(C(3723),TSGMA),(C(3733),TLB),	IO	16
EQUIVALENCE (C(3733), TLB)	MCARLO	29
EQUIVALENCE(C(3721),ITCT),(C(3723),TSGMA),(C(3733),TLB),	IO	16
EQUIVALENCE (C(3743), TUB)	MCARLO	30
*(C(3743),TUB),(C(3753),ITNDX),(C(3763),ITDIST),(C(3773),TSPER),	IO	17
EQUIVALENCE (C(3753), ITNDX)	MCARLO	31
EQUIVALENCE (C(3753), ITNDX)	G2	5
EQUIVALENCE (C(3753), ITNDX)	G2	76
EQUIVALENCE (C(3753), ITNDX)	G5	36
EQUIVALENCE (C(3753),ITNDX),(C(3721),ITCT)	SPOT	10
EQUIVALENCE (C(3753), ITNDX)	SPOT	59
EQUIVALENCE (C(3753),ITNDX),(C(3721),ITCT)	D1	53
EQUIVALENCE (C(3753), ITNDX)	S4	70
EQUIVALENCE (C(3753), ITNDX)	S4	236
*(C(3743),TUB),(C(3753),ITNDX),(C(3763),ITDIST),(C(3773),TSPER),	IO	17
EQUIVALENCE (C(3763),ITDIST)	MCARLO	32

TABLE 84. (Continued)

```
*(C(3743),TUB),(C(3753),ITNDX),(C(3763),ITDIST),(C(3773),TSPER),     IO        17
 EQUIVALENCE (C(3773), TSPER)                                        MCARLO    33
*(C(3743),TUB),(C(3753),ITNDX),(C(3763),ITDIST),(C(3773),TSPER),     IO        17
 EQUIVALENCE (C(3783),TYPPER)                                        MCARLO    34
*(C(3783),TYPPER),(C(3793),TPSIG),(C(3803),TNXST),(C(3813),ITNDX2)   IO        18
 EQUIVALENCE (C(3793), TPSIG)                                        MCARLO    35
*(C(3783),TYPPER),(C(3793),TPSIG),(C(3803),TNXST),(C(3813),ITNDX2)   IO        18
 EQUIVALENCE (C(3803), TNXST)                                        MCARLO    37
*(C(3783),TYPPER),(C(3793),TPSIG),(C(3803),TNXST),(C(3813),ITNDX2)   IO        18
 EQUIVALENCE (C(3813),ITNDX2)                                        MCARLO    36
*(C(3783),TYPPER),(C(3793),TPSIG),(C(3803),TNXST),(C(3813),ITNDX2)   IO        18
 EQUIVALENCE (C(3825),  NCASE), (C( 625),     IBL)                   MC7       33
 EQUIVALENCE (C(3825),  NCASE)                                       IO        25
 COMMON /C/ C(3830)                                                  MC7        7
 COMMON /C/ C(3830)                                                  MCARLO     3
 COMMON /C/ C(3830)                                                  LABCOM     4
 COMMON /C/ C(3830)                                                  LABCOM     5
 COMMON /C/ C(3830)                                                  LABCOM     6
 COMMON /C/ C(3830)                                                  LABCOM     7
 COMMON /C/ C(3830)                                                  SPOT       3
 COMMON /C/ C(3830)                                                  SPOT      52
 COMMON /C/ C(3830)                                                  A1         3
 COMMON /C/ C(3830)                                                  A3         4
 COMMON /C/ C(3830)                                                  A3        91
 COMMON /C/ C(3830)                                                  A2         4
 COMMON /C/ C(3830)                                                  LABCOM    14
 COMMON /C/ C(3830)                                                  LABCOM    15
 COMMON /C/ C(3830)                                                  D2         4
 COMMON /C/ C(3830)                                                  D2        67
 COMMON /C/ C(3830)                                                  S1         4
 COMMON /C/ C(3830)                                                  S1       112
 COMMON /C/ C(3830)                                                  S4         5
 COMMON /C/ C(3830)                                                  S4       207
 COMMON /C/ C(3830)                                                  C1         5
 COMMON /C/ C(3830)                                                  C1        73
 COMMON /C/ C(3830)                                                  LABCOM    24
 COMMON /C/ C(3830)                                                  LABCOM    25
 COMMON /C/ C(3830)                                                  LABCOM    26
 COMMON /C/ C(3830)                                                  LABCOM    27
 COMMON /C/ C(3830)                                                  LABCOM    28
 COMMON /C/ C(3830)                                                  LABCOM    29
 COMMON /C/ C(3830)                                                  C4         3
 COMMON /C/ C(3830)                                                  C4        79
 COMMON /C/ C(3830)                                                  C5         3
 COMMON /C/ C(3830)                                                  C5        60
 COMMON /C/ C(3830)                                                  LABCOM    34
```

TABLE 84. (Concluded)

COMMON /C/ C(3830)	AMRK	3
COMMON /C/ C(3830)	AMRK	49
COMMON /C/ C(3830)	AMRK	134
COMMON /C/ C(3830)	AMRK	226
COMMON /C/ C(3830)	IO	4
COMMON /C/ C(3830)	IO	157
COMMON /C/ C(3830)	IO	189
COMMON /C/ C(3830)	IO	253
COMMON /C/ C(3830)	EXEC	3
COMMON /C/ C(3830)	EXEC	29
COMMON /C/ C(3830)	EXEC	54
COMMON /C/ C(3830)	EXEC	79
COMMON /C/ C(3830)	EXEC	87
COMMON /C/ C(3830)	EXEC	120
COMMON /C/ C(3830)	EXEC	265
COMMON /C/ C(3830)	EXEC	273
COMMON /C/ C(3830)	S2	3
COMMON /C/ C(3830)	S2	274
COMMON /C/ C(3830)	LABCOM	55

V. COMMENTS OR RECOMMENDATIONS

A. Monte Carlo Recommendations

When running parameteic studies that involve time series error sources (such as spot jitter and/or wind gusts), it is strongly recommended that the integration stepsize remain fixed for all sets of runs. It is important to maintain the same set of nominal conditions as closely as possible from run set to run set in order to have consistent results for comparison purposes (do not compare a CEP generated at 1 = 1' with CEP generated at 1 = 2'). While making checkout runs with the Monte Carlo program, it was discovered that the statistical properties of the time series output (spot jitter in particular) changes with changes in integration stepsize. A stepsize of 0.0125 sec produced a spot jitter standard deviation (σ) of 0.92 ft while a stepsize of 0.0100 sec produced a standard deviation of 1.09 ft. Thus, the statistical properites can change as much as $\pm$ 10%. This increases the uncertainty of the results which are already subject to statistical uncertainties due to the finite number of impact points in the CEP calculations.

The statistical properties of the time series output changes with the stepsize because the random number calling frequency changes (the frequency is inherently a function of stepsize due to the digital nature of numerical integration techniques). An attempt to compensate for the effect of calling frequency on the filter output is made through the gain equation, G, of Section III. B. 3. b. The stepsize, t, appears in the radical of this equation as a result of trying to compensate for using discrete white noise as input to the filter instead of continuous white noise.

If the integration stepsize must be changed, it is suggested that a Monte Carlo run be made using the desired stepdize in order to determine what is the RMS of the time series error source. Then, the input standard deviation (SIGSPOT for spot jitter and SIGU for wind gusts) may be changed to produce the desired statistical output. The new value of SIGSPOT or SIGU is computed by dividing the current value of the input SIGSPOT or SIGU by the average RMS output at the end of each run. (For spot jitter, use the average value of the radial RMS output.)

B. Integration Synchronization with Sample Period

Numerical integration must be synchronized with sample period* (τ at ZOH) in order to insure accurate integration. Logic is built into the seeker subroutines to insure that integration and sample period are synchronized. This is ascomplished by:

$$t = \tau/\left[AINT(\tau/\ t_{INPUT})\right] \quad ,$$

where

τ	=	ZOH smaple period (sec)
Δt_{INPUT}	=	input integration stepsize (sec)
AINT(X)	=	computer center library function that integerizes the argument (X).
Δt	=	computer integration stepsize that the program will use.

The previously mentioned function will always compute an integration stepsize that is equal to or greater than the input stepsize. Since there is an upper bound on the stepsize that can be used to integrate the differential equations in this simulation program, there is the possibility that a stepsize larger than the upper bound will be computed. (Upper bound is approximately 12.5 msec, with the exception of the optical contrast signal seeker model S2 which has an upper bound of approximately 0.5 msec). Therefore, one should insure that a reasonable stepsize is input and verify that a reasonable stepsize is computed. For example, if the sample period is 16.7 msec, then a stepsize of 8.35 msec or less must be input to insure that the computed stepsize is 12.5 msec or less.

VI. C-ARRAY CROSS REFERENCE

Table 84 contains a computer program listing cross reference of the C-array. This table contains the location, in numerical order, of every reference to a C index. The most important feature of this table is that it identifies all variables that are equivalenced to the C array.

The first column contains the Fortran statement in which a C index is used. The second column contains the module or subroutine group name where the C-index is referenced. The third column contains the line number of the module or subroutine group where the C-index reference is located. For example, the first entry in Table 84 is C(11), which is equivalenced to BY. C(11) is referenced at lines 13 and 165 of module S1, and at lines 44 and 287 of module S4.

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*A discussion of errors caused by numerical integration of sample data is given in Reference 2.

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9. Ball, R. F., Lee, A. W., Jr., and Lewis, C. L., An Engineering and Programming Guide for a Six Degree of Freedom Terminal Homing Simulation Program, US Army Missile Command, Redstone Arsenal, Alabama, 10 October 1973, Technical Report RG-73-22.

Appendix A. ANGULAR ACCELERATION EQUATIONS

The angular acceleration equations implemented in the 6 DOF program (subroutine D2) are

$$\omega_{PD} = \frac{FMXBA}{FMIX} \; CRAD$$

$$\omega_{QD} = \frac{FMYBA \cdot CRAD + (FMIZ - FMIX)\,\dfrac{\omega_P \omega_R}{CRAD}}{FMIY}$$

$$RD = \frac{FMZBA \cdot CRAD + (FMIX - FMIY)\,\dfrac{\omega_P \omega_Q}{CRAD}}{FMIZ} \quad , \qquad \text{(A-1)}$$

where

ω_{PD} = Angular acceleration about X_B

ω_{QD} = Angular acceleration about Y_B

ω_{RD} = Angular acceleration about Z_B

FMXBA = Applied moment about X_B

FMYBA = Applied moment about Y_B

FMZBA = Applied moment about Z_B

FMIX = Moment of inertia about X_B

FMIY = Moment of inertia about Y_B

FMIZ = Moment of inertia about Z_B .

Equation (A-1) is based on the assumption that (1) FMITZ = FMIY (because of vehicle symmetry about X_B), and (2) the products of inertia are zero (not strictly true, even initially).

Equations (A-1) is derived as follows:

$$\overline{\Delta} = \overline{\overline{I}}\;\overline{\omega} \quad ,$$

where $\overline{\Delta}$ is the angular momentum vector, $\overline{\overline{I}}$ is the inertial tensor, and $\overline{\omega}$ is the angular velocity vector, all in the body coordinate system. Now,

$$\frac{d}{dt}\overline{\Delta} = \frac{d}{dt}(\overline{\overline{I}}\,\overline{\omega}) = \overline{\nabla} \quad ,$$

i.e., the time derivative of the angular momentum vector equals the torque vector where,

$$\overline{\overline{I}} = \begin{bmatrix} I_{XX} & 0 & 0 \\ 0 & I_{YY} & 0 \\ 0 & 0 & I_{ZZ} \end{bmatrix}_{E_B}$$

$$\overline{\omega} = \frac{1}{CRAD}\begin{bmatrix} \omega_P \\ \omega_Q \\ \omega_R \end{bmatrix}_{E_B} \quad .$$

So,

$$\overline{\overline{I}}\,\overline{\omega} = \left(I_{XX}(\omega_P)\overline{X}_B + I_{YY}(\omega_Q)\overline{Y}_B + I_{ZZ}(\omega_R)\overline{Z}_B\right)\frac{1}{CRAD}$$

where $\overline{X}_B$, $\overline{Y}_B$, and $\overline{Z}_B$ are unit vectors in the body system. Thus,

$$\begin{aligned} \frac{d}{dt}(\overline{\overline{I}}\,\overline{\omega}) &= \frac{1}{CRAD} \quad I_{XX}(\dot{\omega}_P)\overline{X}_B + I_{XX}(\omega_P)\dot{\overline{X}}_B + I_{YY}(\dot{\omega}_Q)\overline{Y}_B \\ &\quad + I_{YY}(\omega_Q)\dot{\overline{Y}}_B + I_{ZZ}(\dot{\omega}_R)\overline{Z}_B + I_{ZZ}(\omega_R)\dot{\overline{Z}}_B \\ &= M_X\overline{X}_B + M_Y\overline{Y}_B + M_Z\overline{Z}_B \quad , \qquad \text{(A-2)} \end{aligned}$$

where the assumption is made that

$$\dot{I}_{XX} = \dot{I}_{YY} = \dot{I}_{ZZ} = 0 \quad .$$

The time derivatives of the unit vectors $\overline{X}_B$, $\overline{Y}_B$, and $\overline{Z}_B$ are

$$\dot{\overline{X}}_B = \frac{\omega_R \overline{Y}_B - \omega_Q \overline{Z}_B}{CRAD}$$

$$\dot{\overline{Y}}_B = \frac{\omega_P \overline{Z}_B - \omega_R \overline{X}_B}{CRAD}$$

$$\dot{\overline{Z}}_B = \frac{\omega_Q \overline{X}_B - \omega_P \overline{Y}_B}{CRAD} \quad . \tag{A-3}$$

Making these substitutions in Equation (A-3) and collecting terms,

$$\frac{1}{CRAD} \left\{ \left(I_{XX}(\dot{\omega}_P) - \frac{I_{YY}(\omega_Q)(\omega_R)}{CRAD} + \frac{I_{ZZ}(\omega_R)(\omega_Q)}{CRAD} \right) \overline{X}_B \right.$$
$$+ \left(I_{YY}(\dot{\omega}_Q) + \frac{I_{XX}(\omega_P)(\omega_R)}{CRAD} - \frac{I_{ZZ}(\omega_R)(\omega_P)}{CRAD} \right) \overline{Y}_B$$
$$\left. + \left(I_{ZZ}(\dot{\omega}_R) - \frac{I_{XX}(\omega_P)(\omega_Q)}{CRAD} - \frac{I_{YY}(\omega_Q)(\omega_P)}{CRAD} \right) \overline{Z}_B \right\}$$

$$= M_X \overline{X}_B + M_Y \overline{Y}_B + M_Z \overline{Z}_B \quad .$$

Simplifying,

$$\left(I_{XX}(\dot{\omega}_P) + \frac{(I_{ZZ} - I_{YY})(\omega_R)(\omega_Q)}{CRAD} \right) \overline{X}_B$$
$$+ \left(I_{YY}(\dot{\omega}_Q) + \frac{(I_{XX} - I_{ZZ})(\omega_P)(\omega_R)}{CRAD} \right) \overline{X}_B$$
$$+ \left(I_{ZZ}(\dot{\omega}_R) + \frac{(I_{YY} - I_{XX})(\omega_P)(\omega_Q)}{CRAD} \right) \overline{X}_B$$
$$= CRAD \; (M_X \overline{X}_B + M_Y \overline{Y}_B - M_Z \overline{Z}_B) \quad .$$

Equating like coefficients and solving for (ω_P), (ω_Q), (ω_R), and noting that $I_{YY} = I_{ZZ}$

$$\dot{\omega}_P = \frac{M_X \cdot CRAD}{I_{XX}}$$

$$\dot{\omega}_Q = \left(M_Y \cdot CRAD + \frac{(I_{ZZ} - I_{XX})(\omega_P)(\omega_R)}{CRAD} \right) \frac{1}{I_{YY}}$$

$$\dot{\omega}_R = \left(M_Z \cdot CRAD + \frac{(I_{XX} - I_{YY})(\omega_P)(\omega_Q)}{CRAD} \right) \frac{1}{I_{ZZ}} \quad .$$

Substituting the program names in Equation (4), yields Equation (1).

Appendix B. TIME DERIVATIVES OF THE EARTH TO BODY AXES TRANSFORMATION MATRIX, M

The time derivative of the earth to body axes transformation matrix, d/dt(M) can be obtained as follows:

(1) Let $\overline{X}_B$, $\overline{Y}_B$, $\overline{Z}_B$, and $\overline{X}_E$, $\overline{Y}_E$, $\overline{Z}_E$ denote unit vectors in the body and earth system, respectively.

(2) Assume the unit vectors in E_B have angular velocity components about $\overline{X}_B$, $\overline{Y}_B$, $\overline{Z}_B$ of ω_P, ω_Q, and ω_R (deg/sec), respectively.

Then the time derivatives of the unit vectors $M^T E_B$, (where M^T denotes the transpose of the matrix, M), written in terms of ω_P, ω_Q, and ω_R are (see Figure B-1 for velocity components):

$$\dot{\overline{X}}_B = \frac{0\overline{X}_B + \omega_R\overline{Y}_B - \omega_Q\overline{Z}_B}{\text{CRAD}} = \begin{bmatrix} 0 \\ \omega_R \\ -\omega_Q \end{bmatrix}_{E_B}$$

$$\dot{\overline{Y}}_B = \frac{-\omega_R\overline{X}_B + 0\overline{Y}_B + \omega_P\overline{Z}_B}{\text{CRAD}} = \begin{bmatrix} -\omega_R \\ 0 \\ \omega_P \end{bmatrix}_{E_B}$$

$$\dot{\overline{Z}}_B = \frac{\omega_Q\overline{X}_B - \omega_P\overline{Y}_B + 0\overline{Z}_B}{\text{CRAD}} = \begin{bmatrix} \omega_Q \\ -\omega_P \\ 0 \end{bmatrix}_{E_B} ,$$

where CRAD is the number of degrees per radian.

Transforming $\dot{\overline{X}}_B$, $\dot{\overline{Y}}_B$, $\dot{\overline{Z}}_B$ into the earth coordinate systems E_E yields

$$\begin{bmatrix} \dot{X}_B \end{bmatrix}_{E_E} = M^T\dot{\overline{X}}_B = \begin{bmatrix} C_{11} & C_{21} & C_{31} \\ C_{12} & C_{22} & C_{32} \\ C_{13} & C_{23} & C_{33} \end{bmatrix} \dot{\overline{X}}_B = \begin{bmatrix} C_{21} & \omega_R - C_{31} & \omega_Q \\ C_{22} & \omega_R - C_{32} & \omega_Q \\ C_{23} & \omega_R - C_{33} & \omega_Q \end{bmatrix}_{E_E}$$

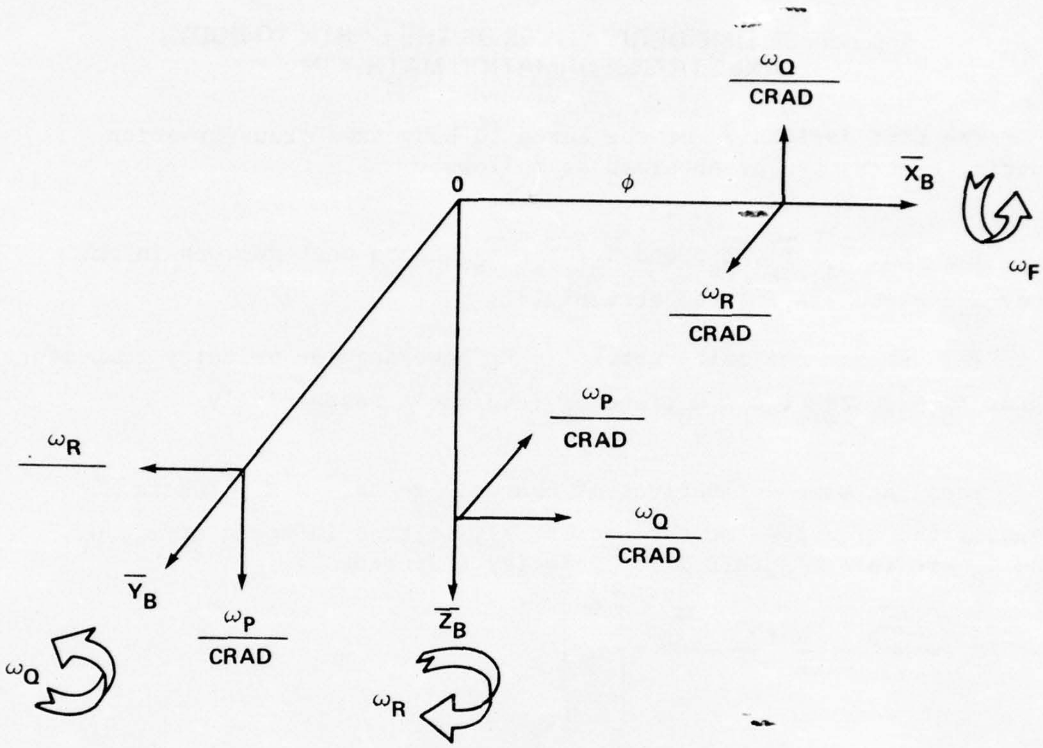

Figure B-1.

$$\left[\dot{\overline{Y}}_B\right]_{E_E} = M^T \dot{\overline{Y}}_B = \begin{bmatrix} -C_{11}\ \omega_R + C_{31}\ \omega_P \\ -C_{12}\ \omega_R + C_{32}\ \omega_P \\ -C_{13}\ \omega_R + C_{33}\ \omega_P \end{bmatrix}_{E_E}$$

$$\left[\dot{\overline{Z}}_B\right]_{E_E} = M^T \dot{\overline{Z}}_B = \begin{bmatrix} C_{11}\ \omega_Q - C_{21}\ \omega_P \\ C_{12}\ \omega_Q - C_{22}\ \omega_P \\ C_{13}\ \omega_Q - C_{23}\ \omega_P \end{bmatrix}_{E_E} .$$

But the time derivatives of the unit vectors $\overline{X}_B$, $\overline{Y}_B$, $\overline{Z}_B$, can also be expressed in the E_E system by first transforming into the E_E system and then taking the time derivatives. Thus,

$$\left[X_B\right]_{E_E} = M^T\overline{X}_B = \begin{bmatrix} C_{11} & C_{21} & C_{31} \\ C_{12} & C_{22} & C_{32} \\ C_{13} & C_{23} & C_{33} \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}_{E_B} = \begin{bmatrix} C_{11} \\ C_{12} \\ C_{13} \end{bmatrix}_{E_B}$$

$$\left[Y_B\right]_{E_E} = M^T\overline{Y}_B = \begin{bmatrix} C_{21} \\ C_{22} \\ C_{23} \end{bmatrix}_{E_B}$$

$$\left[Z_B\right]_{E_E} = \begin{bmatrix} C_{31} \\ C_{32} \\ C_{33} \end{bmatrix}_{E_B} \quad .$$

Written in terms of the unit vectors $\overline{X}_E$, $\overline{Y}_E$, and $\overline{Z}_E$,

$$\left[X_B\right]_{E_E} = C_{11}\,\overline{X}_E + C_{12}\,\overline{Y}_E + C_{13}\,\overline{Z}_E$$

$$\left[Y_B\right]_{E_E} = C_{21}\,\overline{X}_E + C_{22}\,\overline{Y}_E + C_{23}\,\overline{Z}_E$$

$$\left[Z_B\right]_{E_E} = C_{31}\,\overline{X}_E + C_{32}\,\overline{Y}_E + C_{33}\,\overline{Z}_E \quad .$$

Since the E_E system is considered fixed; i.e., $\dot{\overline{X}}_E$, $\dot{\overline{Y}}_E$, $\dot{\overline{Z}}_E = 0$,

$$\frac{d}{dt}\left[X_B\right]_{E_E} = \dot{C}_{11}\,\overline{X}_E + \dot{C}_{12}\,\overline{Y}_E + \dot{C}_{13}\,\overline{Z}_E = \begin{bmatrix} \dot{C}_{11} \\ \dot{C}_{12} \\ \dot{C}_{13} \end{bmatrix}_{E_E}$$

$$\frac{d}{dt}\left[Y_B\right]_{E_E} = \begin{bmatrix} \dot{C}_{21} \\ \dot{C}_{22} \\ \dot{C}_{23} \end{bmatrix}_{E_E}$$

$$\frac{d}{dt}\left[Z_B\right]_{E_E} = \begin{bmatrix} \dot{C}_{31} \\ \dot{C}_{32} \\ \dot{C}_{33} \end{bmatrix}_{E_E}$$

Since the corresponding expression obtained by the two methods represent the same vectors, from 1 and 2, it follows that

$$\dot{C}_{11} = C_{21}\,\omega_R - C_{31}\,\omega_Q$$
$$\dot{C}_{12} = C_{22}\,\omega_R - C_{32}\,\omega_Q$$
$$\dot{C}_{13} = C_{23}\,\omega_R - C_{33}\,\omega_Q$$
$$\dot{C}_{21} = C_{31}\,\omega_P - C_{11}\,\omega_R$$
$$\dot{C}_{22} = C_{32}\,\omega_P - C_{12}\,\omega_R$$
$$\dot{C}_{23} = C_{33}\,\omega_P - C_{13}\,\omega_R$$
$$\dot{C}_{31} = C_{11}\,\omega_Q - C_{21}\,\omega_P$$
$$\dot{C}_{32} = C_{12}\,\omega_Q - C_{22}\,\omega_P$$
$$\dot{C}_{33} = C_{13}\,\omega_Q - C_{23}\,\omega_P \quad .$$

Appendix C. ORIENTATION OF BODY AND EARTH AXES

The Euler angles which orient the body axis system with respect to the earth sxis system (Figure C-1) are defined as follows:

1) A positive rotation (toward Y_E from X_E) of ψ (deg) about the Z_E-axis, giving a system E' (X^1, Y^1, Z^1).

2) A negative rotation (The X^1-axis up from the plane of the earth axis system) of θ about the Y^1-axis, giving a system E'' (X'', Y'', Z'').

3) A positive rotation (toward Z'' from Y'') of degrees about the X''-axis, giving the body axis system $E_B(X_B, Y_B, Z_B)$.

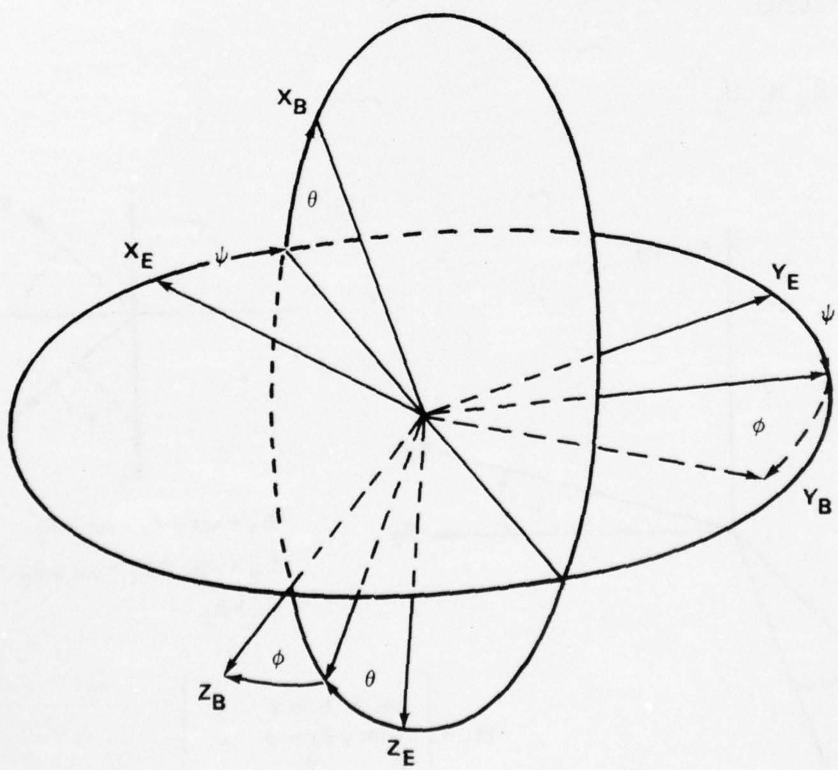

Figure C-1. Euler angles which orient the body axis system with respect to the earth axis system.

AD-A032 048 ARMY MISSILE RESEARCH DEVELOPMENT AND ENGINEERING LAB--ETC F/G 16/4
THAD T-7 MISSILE MONTE-CARLO TERMINAL HOMING SIMULATION UTILIZI--ETC(U)
JUL 76 C L LEWIS, W R HOOKER, A W LEE

UNCLASSIFIED RG-7T-2 NL

4 OF 7
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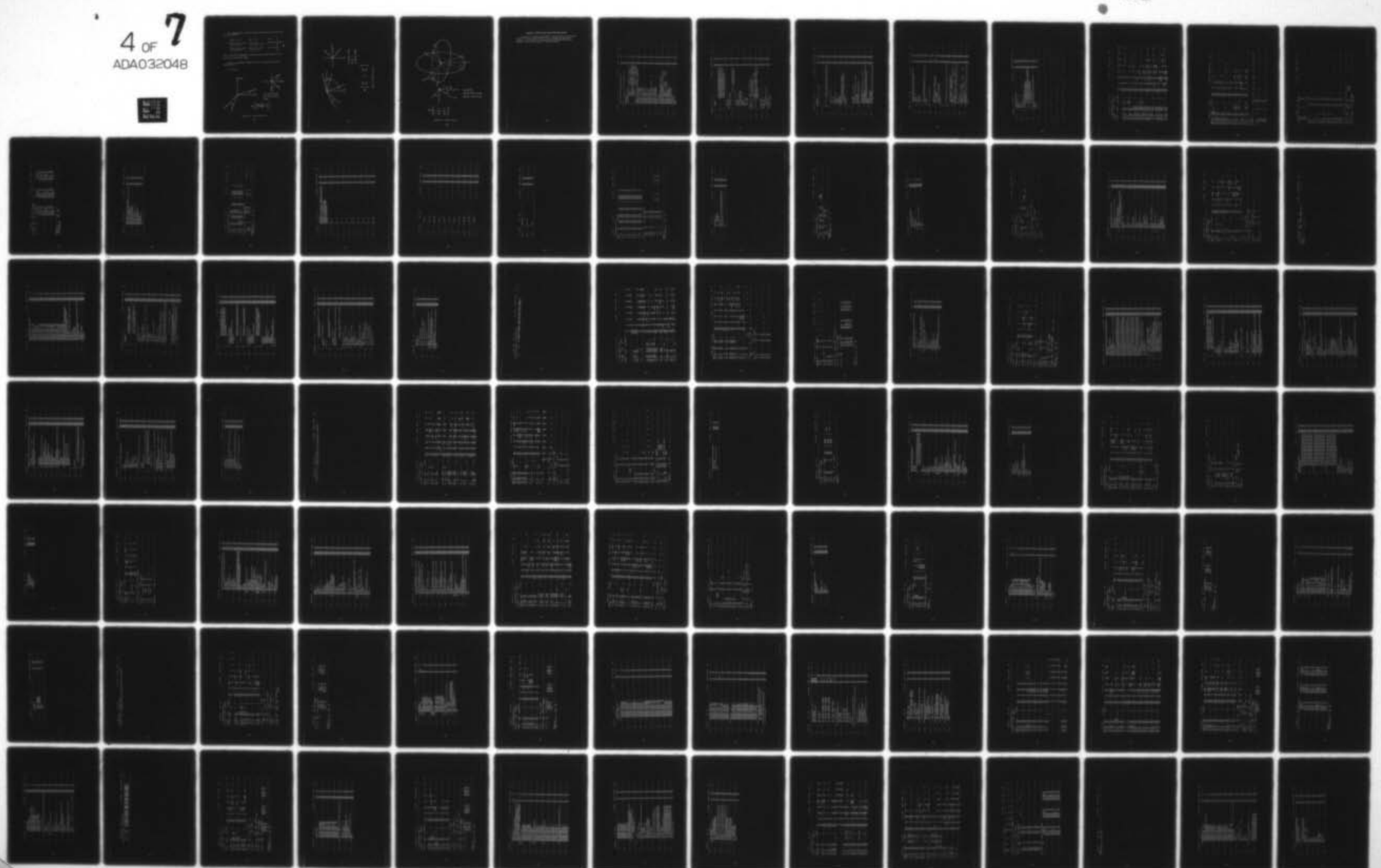

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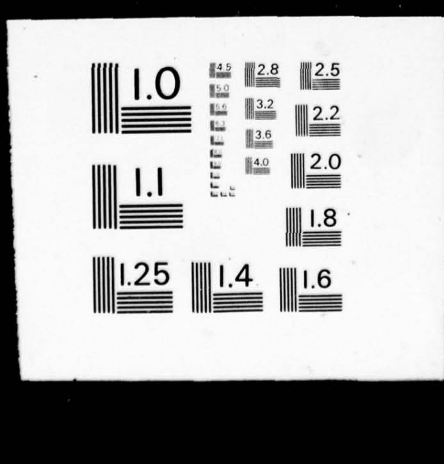


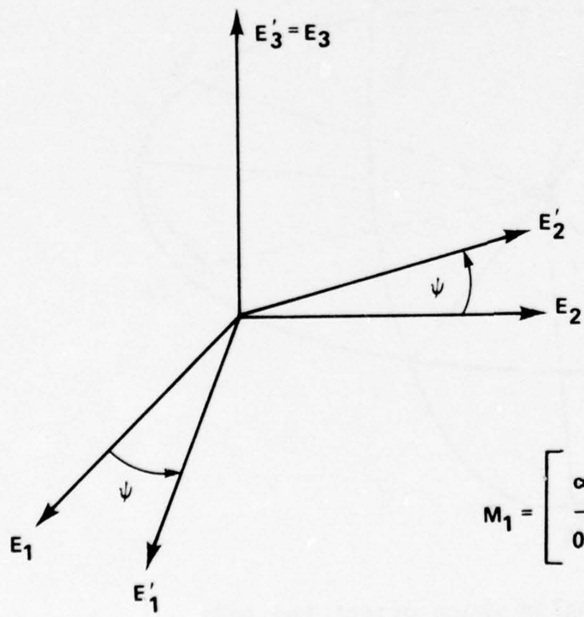
The transformation, M, from the earth axis system to the body axis system is given by

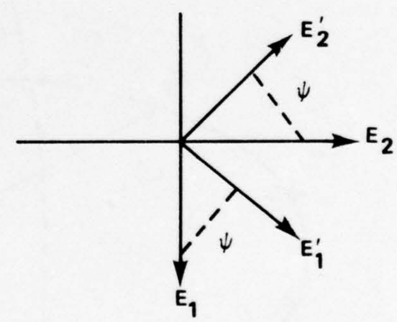
$$M = \begin{bmatrix} \cos\psi\cos\theta & \sin\psi\cos\theta & -\sin\theta \\ \cos\psi\sin\theta\sin\Phi - \sin\psi\cos\Phi & \cos\psi\cos\Phi + \sin\psi\sin\theta\sin\Phi & \cos\theta\sin\Phi \\ \cos\psi\sin\theta\cos\Phi + \sin\psi\sin\Phi & \sin\psi\sin\theta\cos\Phi - \cos\psi\sin\Phi & \cos\theta\cos\Phi \end{bmatrix} \quad \text{(C-1)}$$

Thus, a vector $\overline{V}_E$ expressed in the earth axis system is given in the body axis system as $\overline{V}_B = M\overline{V}_E$.

Then, M, as defined in Equation (C-1) is obtained from matrix multiplication,

$$M = M_3\, M_2\, M_1 \quad .$$





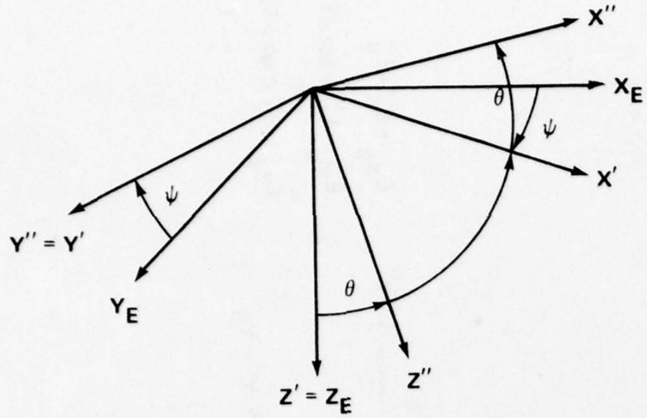
$E'_1 = \cos\psi\, E_1 + \sin\psi\, E_2$

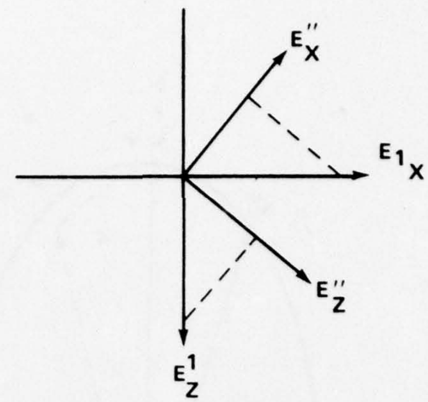
$E'_2 = -\sin\psi\, E_1 + \cos\psi\, E_2$

$E'_3 = E_3$

$$M_1 = \begin{bmatrix} \cos\psi & E\sin\psi & 0 \\ -\sin\psi & E\cos\psi & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Figure C-2. First rotation, ψ.





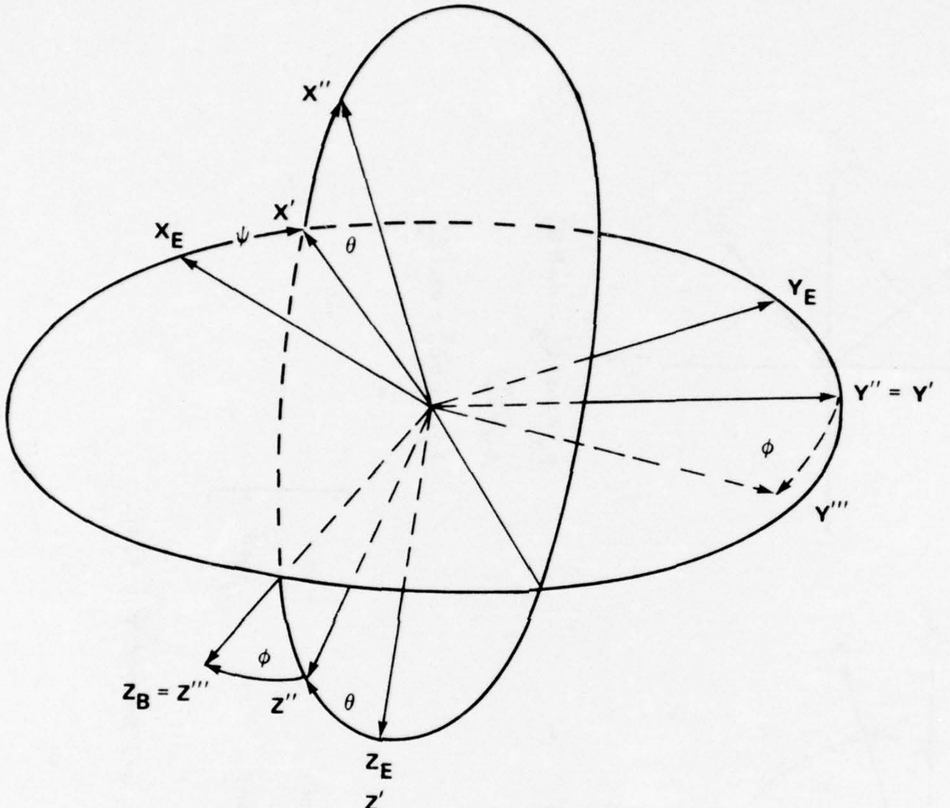
$$E''_X = \cos\theta\, E^1_X - \sin\theta\, E^1_Z$$

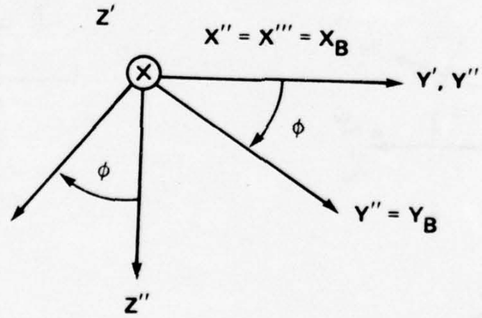
$$E''_Y = E^1_Y$$

$$E''_Z = \sin\theta\, E^1_X + \cos\theta\, E^1_Z$$

$$M_2 = \begin{bmatrix} \cos\theta & 0 & -\sin\theta \\ 0 & 1 & 0 \\ \sin\theta & 0 & \cos\theta \end{bmatrix}$$

Figure C-3 Second rotation.





$$E_{X_B} = E'''_X = E'''_X$$

$$E_{Y_B} = E''_Y = \cos\phi E''_Y + \sin\phi E''_Z$$

$$E_{Z_B} = E'''_Z = \sin\phi E''_Y + \cos\phi E''_Z$$

$$M_3 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\phi & \sin\phi \\ 0 & -\sin\phi & \cos\phi \end{bmatrix}$$

Figure C-4. Third rotation.

Appendix D. MONTE CARLO 6-DOF PROGRAM LISTING

A Fortran IV listing of the THAD T-7 missile version of the Monte Carlo 6 DOF point target terminal homing, all-digital simulation follows. It is currently in operation on MICOM's CDC 6600 digital computer, utilizing the SCOPE 3.4 operating system.

```
      PROGRAM MAIN(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)                MC7       2
     . )                                                                 MC7       3
C                                                                        MC7       4
C*****DIMGES TO BE USED WITH FORTRAN AMRK INTEGRATION ROUTINE            MC7       5
C                                                                        MC7       6
      COMMON /C/ C(3830)                                                 MC7       7
      COMMON GRAPH                                                       MC7       8
      COMMON/CEPASS/X(100),Y(100)                                        MC7       9
      EQUIVALENCE (C(2562),HMIN  ), (C(2663),HMAX  ), (C(2664),DER   ),  MC7      10
C                 (C(2561),N     ), (C(2562),IPL   ), (C(2965),VAR   ),  MC7      11
C                 (C(2000),T     ), (C(2011),KSTEP ), (C(2010),STEP  ),  MC7      12
C                 (C(2012),LSTEP ), (C(2008),PLOTNO), (C(2009),NOPLOT),  MC7      13
C                 (C(2023),OPOINT), (C(2025),TIME  ), (C(2325),VLABLE),  MC7      14
C                 (C(3167),NOOUT ), (C(2022),OPTN10), (C(2006),REPPLT),  MC7      15
C                 (C(2865),EU    ), (C(2765),EL    ), (C(2007),PTLESS)   MC7      16
      EQUIVALENCE                   (C(1971),RITE  ), (C(1972),RKUTTA)   MC7      17
      EQUIVALENCE (C(1973),KASE  ), (C(1974),NJ    ), (C(1975),NPT   )   MC7      18
      EQUIVALENCE (C(3512),ISGCT),(C(3721),ITCT),(C(3511),RNSTRT)        MC7      19
      EQUIVALENCE (C( 21),IBVNSW)                                        MC7      20
      EQUIVALENCE (C( 22), IPLOT)                                        MC7      21
      EQUIVALENCE (C( 23),XLAMBD)                                        MC7      22
      EQUIVALENCE (C( 24), KSSIG)                                        MC7      23
      EQUIVALENCE (C( 25),CEPSIG)                                        MC7      24
      EQUIVALENCE (C(300),RMISS)                                         MC7      25
      DIMENSION RMISST(100)                                              MC7      26
      EQUIVALENCE (C(1000),RMISST)                                       MC7      27
      EQUIVALENCE (C(301),     L)                                        MC7      28
      EQUIVALENCE (C(302),   RYF)                                        MC7      29
      EQUIVALENCE(C(19),PSIZE)                                           MC7      30
      EQUIVALENCE (C(303),   RZF)                                        MC7      31
      EQUIVALENCE (C( 31),LSEP)                                          MC7      32
      EQUIVALENCE (C(3825),  NCASE), (C( 625),    IBL)                   MC7      33
      EQUIVALENCE (C(2662)   ,DERSV)                                     MC7      34
      EQUIVALENCE (C(3000),VSD   )                                       MC7      35
      EQUIVALENCE (C(3010),VMEAN )                                       MC7      36
      EQUIVALENCE (C(3020),IMVNDX)                                       MC7      37
      EQUIVALENCE (C(3030),IMVCT )                                       MC7      38
      REAL KSSIG                                                         MC7      39
      INTEGER CEPSIG                                                     MC7      40
      DIMENSION CEPSIG(6)                                                MC7      41
      DIMENSION ISCALE(15),YMAX(15),YMIN(15),TIMLAB(2)                   MC7      42
C     DIMENSION GRAPH(300,15),TIME(300)                                  MC7      43
      EQUIVALENCE (C(1901),ISCALE),(C(1916),YMAX),(C(1931),YMIN)         MC7      44
      DIMENSION GRAPH(1,1),TIME(300)                                     MC7      45
      DIMENSION   VLABLE(2,15)    , IPL(100)        , DER(101)           MC7      46
      DIMENSION   VAR(101)        , EL(100)         , EU(100)            MC7      47
      DIMENSION IMVNDX(10), VMEAN(10), VSD(10)                           MC7      48
      EQUIVALENCE (C(1980),RN    )                                       MC7      49
      EQUIVALENCE (C(1981),RNT   )                                       MC7      50
      EQUIVALENCE (C(1982),PLOTN4)                                       MC7      51
      EQUIVALENCE (C(1983),PLOTN2)                                       MC7      52
      EQUIVALENCE (C(1984),NPLOT )                                       MC7      53
      INTEGER OPOINT                                                     MC7      54
      INTEGER OPT                                                        MC7      55
      EXTERNAL AUXSUB                                                    MC7      56
      ISGCT=0                                                            MC7      57
      ITCT=0                                                             MC7      58
```

```
      MODE=-1                                                           MC7  59
      ITSWCX=0                                                          MC7  60
C                                                                       MC7  61
C                                                                       MC7  62
C               THIS CALL TO SUBROUTINE RANNUM IS TO PERMIT USE OF      MC7  63
C               DIFFERENT RANDOM NUMBER GENERATOR STARTERS (IRNST).     MC7  64
C               IF SUBROUTINE NORMAL IS CALLED WITHOUT FIRST CALLING    MC7  65
C               RANNUM, THE RANDOM NUMBER SEQUENCE WILL ALWAYS          MC7  66
C               BE STARTED WITH THE SAME NUMBER (ENTERED AS A DATA      MC7  67
C               STATEMENT IN SUBROUTINE NORMAL), WHICH WILL RESULT      MC7  68
C               IN THE SAME SEQUENCE ALWAYS BEING GENERATED.            MC7  69
      L = 1                                                             MC7  70
      NP = 0                                                            MC7  71
      CALL COUNTV                                                       MC7  72
 1000 CALL ZERO                                                         MC7  73
 1001 IF(PLOTNO.LE.0.)GOTO7                                             MC7  74
      IF(REPPLT.GT.0.)GOTO7                                             MC7  75
C                                                                       MC7  76
C                         REPPLT = 0.  USE NEW NO.4,7 (DISCARD OLD)     MC7  77
C                                  1.  USE OLD PLUS THOSE ADDED         MC7  78
C                                 -1.  USE NEW NO. 7 (DISCARD OLD)      MC7  79
      IF (REMPLT.GT.-1.0) NOOUT = 0                                     MC7  80
      NPLOT=0                                                           MC7  81
    7 CALL DINPT1                                                       MC7  82
    8 CONTINUE                                                          MC7  83
      IF(ISGCT.LE.0)GO TO 4                                             MC    1
      CALL RANNUM(1.,RNSTRT,DUM)                                        MC    2
      CALL MCARLO(DUM,-1,IDUM)                                          MC    3
      CONTINUE                                                          MC    4
    4 C(1976) = 1.                                                      MC7  86
      KASE=0                                                            MC7  87
      LSTEP = STEP                                                      MC7  88
      NPLOT4 =PLOTN4                                                    MC7  89
      NPLOT2 =PLOTN2                                                    MC7  90
C                                                                       MC7  91
C3 PPF               2005    PLOT INTERVAL (SEC)                        MC7  92
C3 PLOT START TIME   2002                                               MC7  93
C3 NPLOT4            1982   DONT PLOT AGAINST TIME                      MC7  94
C3 NPLOT2            1983 NUMBER OF PAIRED PLOTS                        MC7  95
C7    --LABEL-----INDEX F   --UPPER LIM----**LOWER LIM****              MC7  96
C       9        20 21 25 27   31          45 46          60            MC7  97
C F SCALE FLAG. 0-AUTOMATIC SCALING 1 - FIXED SCALE ON Y-AXES           MC7  98
C             2 - FIXED SCALING ON X- AND Y-AXIS.  FOR PAIRED PLOTS     MC7  99
C             7 CARDS MUST BE FIRST IN 7 CARD SET.  X- VARIABLE FIRST   MC7 100
C             Y- VARIABLE SECOND                                        MC7 101
C                                                                       MC7 102
      NOPLOT=NPLOT                                                      MC7 103
 1002 CALL  SUBL1                                                       MC7 104
 1003 CALL  AUXI                                                        MC7 105
 1004 CALL  SUBL2                                                       MC7 106
 1005 CONTINUE                                                          MC7 107
      DER(101)=DER(1)                                                   MC7 108
      IF(DER(1).GT.DERSV)DER(1)=DERSV                                   MC7 109
      C(1976)=1.                                                        MC7 110
 1006 CALL   AUXSUB                                                     MC7 111
 1007 NJ=N-1                                                            MC7 112
      CALL AMRK(AUXSUB)                                                 MC7 113
```

```
 1008 CONTINUE
 1009 CALL  SUBL3
      IF ( KSTEP .EQ. 1 ) GO TO 1007
C
C
C
C
C
C
C****************SAVE MISS DISTANCE FOR EACH RUN OF THE MONTE CARLO
C                RUN SET***************************************************
C
C
C
      IF(LCEM.NE.1) GO TO 20
      LCEP=0
      NP = NP + 1
      X(NP) = RYF
      Y(NP) = RZF
      RMISST(NP) = RMISS
      GO TO 21
   20 CONTINUE
      WRITE(6,805)
  805 FORMAT(1H0,///)
      WRITE(6,22) L
   22 FORMAT(1H0,11X,26H*$*$*$ WARNING RUN NUMBER ,I3,
     2       37H DID NOT INTERSECT TARGET PLANE*$*$*$,/,
     3     //,20X,38H$*$*THIS RUN DROPPED FROM DATA SET*$*$)
      WRITE(6,805)
   21 CONTINUE
      L = L + 1
C
C
C
C
C
      CALL PROBES
      IF (OPTN10 .GT. 0.) CALL DUMPO
      CALL RESET
      IF(LSTEP.EQ.5.OR.LSTEP.EQ.7.OR.NOPLOT.EQ.0)GOTO5
      CALL TIMEV(DELT)
      WRITE(6,96)DELT
   96 FORMAT(1H ,17HSTART PLOTTING AT F14.7)
C
C
      IF(NOPLOT.LE.0)GO TO 99
      TIMLAB(1)=4HTIME     $   TIMLAB(2)=4H SEC   $   ITIME=0
      IF(NPLOT4.GT.0)GO TO 95
      DO 94 KPLOT=1,NOPLOT
      CALL PLOT4(ISCALE(KPLOT),XMAX,XMIN,YMAX(KPLOT),YMIN(KPLOT),TIME,
     . GRAPH(1,KPLOT),OPOINT,TIMLAB,VLABLE(1,KPLOT),IP,ITIME)
   94 CONTINUE
   95 CONTINUE
      IF(NPLOT2.EQ.0)GO TO 98
      KKPLOT=1 $   ITIME=1
      DO 93 KPLOT=1,NPLOT2
      CALL PLOT4(ISCALE(KKPLOT),YMAX(KKPLOT),YMIN(KKPLOT),YMAX(KKPLOT+1)
```

```
      .,YMIN(KKPLOT+1),GRAPH(1,KKPLOT),GRAPH(1,KKPLOT+1),JPOINT,       MC7      171
     - VLABLE(1,KKPLOT),VLABLE(1,KKPLOT+1),IP,ITIME)                   MC7      172
       KKPLOT=KKPLOT+2                                                 MC7      173
   93  CONTINUE                                                        MC7      174
   98  CONTINUE                                                        MC7      175
       IP=0                                                            MC7      176
       CALL KSTR(3)                                                    MC7      177
       WRITE(6,97)                                                     MC7      178
   99  CONTINUE                                                        MC7      179
C                                                                      MC7      180
C                                                                      MC7      181
   97 FORMAT(1H ,18HPLOTTING ENDED AT F14.7)                           MC7      182
    5 GO TO (1000,1001,1002,1003,1004,1005,1006,1007,1008,1009,1010),  MC7      183
     1 LSTEP                                                           MC7      184
 1010 CONTINUE                                                         MC7      185
C                                                                      MC7      186
C                                                                      MC7      187
C**** MEAN AND STANDARD DEVIATION                                      EXCEED     1
C                                                                      MC7      189
C                                                                      MC7      190
C                                                                      MC7      191
       WRITE(6,100)                                                    MC7      192
  100 FORMAT(1H1,13X,*MEAN AND STANDARD DEVIATION*//                   EXCEED     2
     1 ,7X*C-LOCATION*9X*MEAN    *19X*STD DEV*/)                       EXCEED     3
       DO 120 I=1,IMVCT                                                MC7      195
       ILOC = IMVNDX(I)                                                MC7      196
       WRITE(6,102) ILOC,VMEAN(I),VSD(I)                               MC7      197
  102 FORMAT(10X,I5,8X,E15.8,11X,E15.8)                                MC7      198
  120 CONTINUE                                                         MC7      199
C                                                                      MC7      200
C                                                                      MC7      201
C                                                                      MC7      202
C                                                                      MC7      203
C                                                                      MC7      204
C************MONTE CARLO AND CEP LOGIC FOLLOWS************************** MC7   205
C                                                                      MC7      206
C                                                                      MC7      207
C                                                                      MC7      208
       IF(NP.LT.NCASE.AND.L.LE.(NCASE+5))WRITE(6,807)                  MC7      209
       IF(NP.LT.NCASE.AND.L.LE.(NCASE+5))GO TO 8                       MC7      210
  807  FORMAT(1H1,3(/),*       THIS RUN ADDED DUE TO BREAKLOCK*,3(/))  MC7      211
       J =0                                                            MC7      212
       WRITE(6,800)                                                    MC7      213
  800 FORMAT(1H1, 96X,10HY-MISS    ,10HZ-MISS    ,10HMISS DIST /,      MC7      214
     1    6X,123H------------------------------------------------------ MC7     215
     2------------------------------------------------------------------ MC7    216
     3--)                                                              MC7      217
       DO 801 I=1,NP                                                   MC7      218
       J = J +1                                                        MC7      219
       WRITE(6,802) X(I),Y(I),RMISST(I)                                MC7      220
  802 FORMAT( 6X,10H1        ,10H1        ,10H1        ,10H1           MC7      221
     1,10H1        ,10H1        ,10H1        ,10H1        ,10H1        MC7      222
     2   ,1H1,F9.5,2H 1,F9.5,2H 1,F8.5,2H 1)                           MC7      223
       WRITE(6,803)                                                    MC7      224
  803 FORMAT( 6X,123H---------------------------------------------------- MC7   225
     2------------------------------------------------------------------ MC7    226
     3------)                                                          MC7      227
```

```
      IF(J.GT.30) WRITE (6,800)
      IF(J.GT.30) J = 0
  801 CONTINUE
      IF(IBL.LE.0)GO TO 804
      L=L-1
      XIBL=IBL
      XL=L
      RATIO=XIBL/XL
      WRITE(6,806)IBL,L,RATIO
  806 FORMAT(1H1,15(/),1X,10(11H*BREAKLOCK*),
     .       /,1X,11H*BREAKLOCK*,88X,11H*BREAKLOCK*,
     .       /,1X,11H*BREAKLOCK*,88X,11H*BREAKLOCK*,
     .       /,1X,11H*BREAKLOCK*,3X,*THIS RUN SET HAD *I4,* BREAKLOCK FL
     .IGHTS OUT OF *I4,* GIVING A PROPORTION OF *F6.4,4X,11H*BREAKLOCK*,
     .       /,1X,11H*BREAKLOCK*,88X,11H*BREAKLOCK*,
     .       /,1X,11H*BREAKLOCK*,88X,11H*BREAKLOCK*,
     .       /1X,10(11H*BREAKLOCK*))
  804 CONTINUE
      CALL GEPAS(NP,IBVNSW,IPLOT,XLAMBD,KSSIG,GEPSIG,PSIZE)
 4000 CONTINUE
      CALL EXIT
      STOP
      END
```

```
        PROGRAM MAIN        74/74    OPT=1                       FTN 4.2+74355        07/07/75  11.03.44.       PAGE    6

        SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE      REFERENCES
 4110  MAIN           1

VARIABLES       SN  TYPE                RELOCATION
     0  C           REAL        ARRAY    C          REFS         6      2*9     2*16     3*17     3*18       19       20
                                                      21        22       23       24       26       27       28       29
                                                      30        31     2*32       33       34       35       36       37
                                                    3*43        48       43       50       51       52
                                                 DEFINED        87      111
    30  CEPSIG      INTEGER     ARRAY    C          REFS        23       33       40      247
  4777  DELT        REAL                            REFS       155      155
  3147  DER         REAL        ARRAY    C          REFS         9       45      109      110  DEFINED      109      110
  3145  DERSV       REAL                 C          REFS        33    2*110
  4773  DUM         REAL                            REFS        84       85
  3314  EL          REAL        ARRAY    C          REFS         9       46
  3460  EU          REAL        ARRAY    C          REFS         9       45
     0  GRAPH       REAL        ARRAY    //         REFS         7       44      164    2*171
  3146  HMAX        REAL                 C          REFS         9
  3145  HMIN        REAL                 C          REFS         9
  3006  I           INTEGER                         REFS       197    2*198    3*221  DEFINED      196      219
  1160  IBL         INTEGER              C          REFS        32      232      234      237
    24  IBVNSW      INTEGER              C          REFS        19      247
  4774  IDJM      * INTEGER                         REFS        85
  3007  ILOC        INTEGER                         REFS       198  DEFINED      197
  3725  IMVCT       INTEGER              C          REFS        37      195
  3713  IMVNDX      INTEGER     ARRAY    C          REFS        36       47      197
  3004  IP          INTEGER                         REFS       164      171  DEFINED      177
  3001  IPL         INTEGER     ARRAY    C          REFS         9       45
    25  IPLOT       INTEGER              C          REFS        20      247
  3554  ISCALE      INTEGER     ARRAY    C          REFS        41       43      164      171
  3667  ISGCT       INTEGER              C          REFS        18       83  DEFINED       56
  7210  ITST        INTEGER              C          REFS        18  DEFINED       57
  3000  ITIME       INTEGER                         REFS       164      171  DEFINED      161      169
  4771  ITSNDX    * INTEGER                      DEFINED        59
  3010  J           INTEGER                         REFS       220      229      230  DEFINED      213      220      230
  3664  KASE        INTEGER              C          REFS        17  DEFINED       88
  3005  KKPLOT      INTEGER                         REFS     9*171      174  DEFINED      169      174
  3001  KPLOT       INTEGER                         REFS     5*164  DEFINED      163      170
    27  KSSIG       REAL                 C          REFS        22       38      247
  3732  KSTEP       INTEGER              C          REFS         9      117
   454  L           INTEGER              C          REFS        27      139      145      210      211      233      235
                                                     237   DEFINED       69      145      233
    36  LCEP        INTEGER              C          REFS        31      129  DEFINED      130
  3733  LSTEP       INTEGER              C          REFS         9    2*154      184  DEFINED       69
  4770  MODE      * INTEGER                      DEFINED        58
  3000  N           INTEGER              C          REFS         9      113
  7360  NCASE       INTEGER              C          REFS        32    2*210    2*211
  3665  NJ          INTEGER              C          REFS        17  DEFINED      113
  3136  NODUT       INTEGER              C          REFS         9  DEFINED       79
  3730  NOPLOT      INTEGER              C          REFS         9      154      160      163  DEFINED      104
  4772  NP          INTEGER                         REFS       131      132      133      134      210      211      219
                                                     247   DEFINED       73      131
  3677  NPLOT       INTEGER              C          REFS        52      104  DEFINED       88
  4776  NPLOT2      INTEGER                         REFS       168      170  DEFINED       91
  4775  NPLOT4      INTEGER                         REFS       162  DEFINED       90
```

```
        PROGRAM MAIN        74/74   OPT=1                           FTN 4.2+74355       07/07/75  11.03.44.        PAGE    7

VARIABLES        SN  TYPE               RELOCATION
 3666  NPT          INTEGER                   C                REFS        17
 3746  OPOINT       INTEGER                   C                REFS         9        53        164       171
 4767  OPT        * INTEGER      *UNDEF                        REFS        54
 3745  OPTN10       REAL                      C                REFS         9       152
 3727  PLOTNO       REAL                      C                REFS         9        73
 3676  PLOTN2       REAL                      C                REFS        51        91
 3675  PLOTN4       REAL                      C                REFS        50        90
   22  PSIZE        REAL                      C                REFS        29       247
 3726  PTLESS       REAL                      C                REFS         9
 3013  RATIO        REAL                                       REFS       237    DEFINED      236
 3725  REPPLT       REAL                      C                REFS         9        74         79
 3662  RITE         REAL                      C                REFS        16
 3663  RKUTTA       REAL                      C                REFS        16
  453  RMISS        REAL                      C                REFS        24       134
 1747  RMISST       REAL         ARRAY        C                REFS        25        25        221    DEFINED       134
 3673  RN           REAL                      C                REFS        48
 3665  RNSTRT       REAL                      C                REFS        18        84
 3674  RNT          REAL                      C                REFS        49
  455  RYF          REAL                      C                REFS        28       132
  456  RZF          REAL                      C                REFS        30       133
 3731  STEP         REAL                      C                REFS         9        89
 3717  T            REAL                      C                REFS         9
 3750  TIME         REAL         ARRAY        C                REFS         9        44        154
 3014  TIMLAB       REAL         ARRAY                         REFS        41       164     DEFINED     2*161
 3624  VAR          REAL         ARRAY        C                REFS         9        45
 4424  VLABLE       REAL         ARRAY        C                REFS         9        45        154      2*171
 3701  VMEAN        REAL         ARRAY        C                REFS        35        47        138
 3667  VSD          REAL         ARRAY        C                REFS        34        47        138
    0  X            REAL         ARRAY        CEPASS           REFS         8       221     DEFINED      132
 3011  XIBL         REAL                                       REFS       236    DEFINED      234
 3012  XL           REAL                                       REFS       236    DEFINED      235
   26  XLAMBD       REAL                      C                REFS        21       247
 3002  XMAX       * REAL                                       REFS       164
 3003  XMIN       * REAL                                       REFS       164
  144  Y            REAL         ARRAY        CEPASS           REFS         8       221     DEFINED      133
 3673  YMAX         REAL         ARRAY        C                REFS        41        43        164      2*171
 3012  YMIN         REAL         ARRAY        C                REFS        41        43        164      2*171

FILE NAMES          MODE
    0  INPUT
 2041  OUTPUT
    0  TAPE5
 2041  TAPE6        FMT                         WRITES     137       139       143       156       179       193       198       210
                                                  214      221       225       223       237

EXTERNALS              TYPE    ARGS         REFERENCES
          AMRK                   1              114
          AUXI                   0              106
          AUXSUB                 0               55       112       114
          CEPAS                  7              247
          COUNTV                 0               71
          DUMPO                  0              152
          EXIT                   0              249
          MCARLO                 3               95
          OINPT1                 0               81
          PLOT4                 12              164       171
          PROCES                 0              151
```

```
EXTERNALS          TYPE   ARGS      REFERENCES
        RANNUM             3            84
        RESET              0            153
        RSTR               1            178
        SUBL1              0            105
        SUBL2              0            107
        SUBL3              0            116
        TIMEV              1            155
        ZERO               0            72

STATEMENT LABELS                 DEF LINE   REFERENCES
  +136   4                          86         83
  +302   5                          184        154
  +127   7                          81         73        74
  +130   8                          82         211
  +177   20                         136        129
  +205   21                         144        135
  +306   22         FMT             140        139
     0   93                         175        170
     0   94                         166        163
  +251   95                         167        162
  +533   96         FMT             157        156
  +542   97         FMT             183        179
  +275   98                         176        168
  +302   99                         180        150
  +552   100        FMT             194        193
  +572   102        FMT             199        198
     0   120                        200        196
  +613   800        FMT             215        214       229
     0   801                        231        219
  +644   802        FMT             222        221
  +670   803        FMT             226        225
  +407   804                        246        232
  +500   805        FMT             138        137       143
  +720   806        FMT             238        237
  +601   807        FMT             212        210
  +117   1000                       72         184
  +120   1001                       73         184
  +147   1002                       105        184
  +150   1003                       106        184
  +151   1004                       107        184
  +152   1005                       108        184
  +160   1006                       112        184
  +161   1007                       113        117       184
  +164   1008                       115        184
  +164   1009                       116        184
  +321   1010                       186        184
     0   4668        INACTIVE       243

LOOPS   LABEL   INDEX      FROM-TO     LENGTH    PROPERTIES
 +236   94      * KPLOT    163 166     133           EXT REFS
 +255   93      * KPLOT    170 175     208           EXT REFS
 +324   120     * I        196 200     128           EXT REFS
 +394   801     * I        219 231     248           EXT REFS

COMMON BLOCKS   LENGTH     MEMBERS - BIAS NAME(LENGTH)
     C           3830             0 C      (3830)
     / /         1                0 GRAPH  (1)
```

```
COMMON BLOCKS   LENGTH      MEMBERS - BIAS NAME(LENGTH)
      CEPASS       200               0 X        (100)              100 Y        (100)

EQUIV CLASSES   LENGTH      MEMBERS - BIAS NAME(LENGTH)
C        C        3830              13 PSIZE    (1)                 20 IBVNSW  (1)                 21 IPLOT   (1)
                                    22 XLAMBD  (1)                 23 KSSIG   (1)                 24 CEPSIG  (6)
                                    30 LCEP    (1)                299 RMISS   (1)                300 L       (1)
                                   301 RYP     (1)                302 RZP     (1)                624 IBL     (1)
                                   399 RMISST  (100)             1900 ISCALE  (15)              1915 YMAX    (15)
                                  1930 YMIN    (15)              1970 RITE    (1)               1971 RKUTTA  (1)
                                  1972 KASE    (1)               1973 NJ      (1)               1974 NPT     (1)
                                  1979 RN      (1)               1980 RNT     (1)               1981 PLOTN4  (1)
                                  1982 PLOTN2  (1)               1983 NPLOT   (1)               1999 T       (1)
                                  2005 REPPLT  (1)               2006 PTLESS  (1)               2007 PLOTNO  (1)
                                  2008 NOPLOT  (1)               2009 STEP    (1)               2010 KSTEP   (1)
                                  2011 LSTEP   (1)               2021 OPTN10  (1)               2022 OPOINT  (1)
                                  2024 TIME    (300)             2324 VLABLE  (30)              2550 N       (1)
                                  2561 IPL     (100)             2661 DERSW   (1)               2651 HMIN    (1)
                                  2662 HMAX    (1)               2663 DER     (101)             2754 EL      (100)
                                  2864 EU      (100)             2964 VAR     (101)             2939 VSD     (10)
                                  3009 VMEAN   (10)              3019 IMVNDX  (10)              3029 IMVCT   (1)
                                  3166 NGOUT   (1)               3510 RNSTRT  (1)               3511 ISGCT   (1)
                                  3720 ITCT    (1)               3824 NCASEI  (1)

STATISTICS
  PROGRAM LENGTH               7148      460
  BUFFER LENGTH               41028     2114
  CM LABELED COMMON LENGTH    75763     4030
  CM BLANK COMMON LENGTH         13        1
```

```
BLOCK DATA A            74/74    OPT=1                    FTN 4.2+74355        07/07/75  11.03.49.        PAGE    1

      BLOCK DATA A                                                              MC7      251
      COMMON /NOS/NCX(6),NCZ(4),NCXO(2),NCZO(6)                                 MC7      252
      COMMON /CXARG/ALP(6),AM(3)   /CZARG/ALP1(6),AM1(4) /CXOARG/AM2(8)         MC7      253
     */CLOARG/ALP3(6),DEF(4),AM3(4)                                             MC7      254
      DATA ALP /0.,4.,8.,12.,16.,20./                                           MC7      255
      DATA ALP1/0.,4.,8.,12.,16.,20./                                           MC7      256
      DATA ALP3/0.,4.,8.,12.,16.,20./                                           MC7      257
      DATA AM /0.,.7,1.1/                                                       MC7      258
      DATA AM1/0.,.7,.9,1.1/                                                    MC7      259
      DATA AM2/0.,.2,.4,.6,.7,.8,1.0,1.2/                                       MC7      260
      DATA AM3/0.,.7,.9,1.1/                                                    MC7      261
      DATA DEF/-20.,-10.,10.,20./                                               MC7      262
      DATA NCX/6,3,0,0,0,0/                                                     MC7      263
      DATA NCZ/6,4,0,0/                                                         MC7      264
      DATA NCXO/8,0/                                                            MC7      265
      DATA NCZO/6,4,4,0,0,0/                                                    MC7      266
      END                                                                       MC7      267
```

```
BLOCK DATA A          74/74    OPT=1                        FTN 4.2+74355      07/07/75  11.03.49.      PAGE     2

         SYMBOLIC REFERENCE MAP (R=3)

VARIABLES      SN  TYPE            RELOCATION
     0  ALP        REAL       ARRAY     CXARG         REFS        3    DEFINED        5
     0  ALP1       REAL       ARRAY     CZARG         REFS        3    DEFINED        6
     0  ALP3       REAL       ARRAY     CLDARG        REFS        3    DEFINED        7
     6  AM         REAL       ARRAY     CXARG         REFS        3    DEFINED        8
     6  AM1        REAL       ARRAY     CZARG         REFS        3    DEFINED        9
     0  AM2        REAL       ARRAY     CXDARG        REFS        3    DEFINED       10
    12  AM3        REAL       ARRAY     CLDARG        REFS        3    DEFINED       11
     6  DEF        REAL       ARRAY     CLDARG        REFS        3    DEFINED       12
     0  NCX        INTEGER    ARRAY     NOS           REFS        2    DEFINED       13
    12  NCXD       INTEGER    ARRAY     NOS           REFS        2    DEFINED       15
     6  NCZ        INTEGER    ARRAY     NOS           REFS        2    DEFINED       14
    14  NCZD       INTEGER    ARRAY     NOS           REFS        2    DEFINED       16

COMMON BLOCKS    LENGTH      MEMBERS - BIAS NAME(LENGTH)
       NOS         18                   0 NCX     (6)            6 NCZ     (4)                10 NCXD    (2)
                                       12 NCZD    (6)
       CXARG        9                   0 ALP     (6)            6 AM      (3)
       CZARG       10                   0 ALP1    (6)            6 AM1     (4)
       CXDARG       8                   0 AM2     (8)
       CLDARG      14                   0 ALP3    (6)            6 DEF     (4)                10 AM3     (4)

STATISTICS
  PROGRAM LENGTH                 0B       0
  CM LABELED COMMON LENGTH      73B      59
```

BLOCK DATA B   74/74   OPT=1   FTN 4.2+74355   07/07/76 11.03.49.   PAGE   1

```
      BLOCK DATA B                                                      MC7      268
      COMMON /CXFUN/CX(18) /CZFUN/CN(24) /DCZFUN/DCN(24) /CMFUN/CM(24)  MC7      269
     */DCMFUN/DCM(24) /CXOFUN/CXO(8) /CN2FUN/CN2(24) /CY2FUN/CY2(24)    MC7      270
     */CL2FUN/CL2(24) /CL3FUN/CL3(24)                                   MC7      271
     */CZOFUN/CN1(24),CN5(24),CN3(24),CN4(24)                           MC7      272
     */CMOFUN/CM1(24),CM2(24),CM3(24),CM4(24)                           MC7      273
     */CLOFUN/CL1(24),CL5(24),CL6(24),CL4(24)                           MC7      274
     */CMQFUN/CMQ(24) /CLPFUN/CLP(24)                                   MC7      275
      DATA  CX  /                                                       MC7      276
     .                                                                  MC7      277
     .                                                                  MC7      278
     .                                                                  MC7      279
      DATA  CN                                                          MC7      280
     .                                                                  MC7      281
     .                                                                  MC7      282
     .                                                                  MC7      283
     .                                                                  MC7      284
      DATA  DCN /                                                       MC7      285
     .                                                                  MC7      286
     .                                                                  MC7      287
     .                                                                  MC7      288
     .                                                                  MC7      289
      DATA  CM  /                                                       MC7      290
     .                                                                  MC7      291
     .                                                                  MC7      292
     .                                                                  MC7      293
     .                                                                  MC7      294
      DATA  DCM /                                                       MC7      295
     .                                                                  MC7      296
     .                                                                  MC7      297
     .                                                                  MC7      298
     .                                                                  MC7      299
      DATA  CXO  /                                                      MC7      300
     .                                                                  MC7      301
      DATA  CN2  /                                                      MC7      302
     .                                                                  MC7      303
     .                                                                  MC7      304
     .                                                                  MC7      305
     .                                                                  MC7      306
      DATA  CY2 /                                                       MC7      307
     .                                                                  MC7      308
     .                                                                  MC7      309
     .                                                                  MC7      310
     .                                                                  MC7      311
      DATA  CL2 /                                                       MC7      312
     .                                                                  MC7      313
     .                                                                  MC7      314
     .                                                                  MC7      315
     .                                                                  MC7      316
      DATA  CL3 /                                                       MC7      317
     .                                                                  MC7      318
     .                                                                  MC7      319
     .                                                                  MC7      320
     .                                                                  MC7      321
      DATA  CN1 /                                                       MC7      322
     .                                                                  MC7      323
     .                                                                  MC7      324
```

```
                                                MC7  325
                                                MC7  326
      DATA CN5/                                 MC7  327
                                                MC7  328
                                                MC7  329
                                                MC7  330
                                                MC7  331
      DATA CN3 /                                MC7  332
                                                MC7  333
                                                MC7  334
                                                MC7  335
                                                MC7  336
      DATA CN4 /                                MC7  337
                                                MC7  338
                                                MC7  339
                                                MC7  340
                                                MC7  341
      DATA CL1 /                                MC7  342
                                                MC7  343
                                                MC7  344
                                                MC7  345
                                                MC7  346
      DATA CL5/                                 MC7  347
                                                MC7  348
                                                MC7  349
                                                MC7  350
                                                MC7  351
      DATA CL6/                                 MC7  352
                                                MC7  353
                                                MC7  354
                                                MC7  355
                                                MC7  356
      DATA CL4 /                                MC7  357
                                                MC7  358
                                                MC7  359
                                                MC7  360
                                                MC7  361
      DATA CM1 /                                MC7  362
                                                MC7  363
                                                MC7  364
                                                MC7  365
                                                MC7  366
      DATA CM2 /                                MC7  367
                                                MC7  368
                                                MC7  369
                                                MC7  370
                                                MC7  371
      DATA CM3 /                                MC7  372
                                                MC7  373
                                                MC7  374
                                                MC7  375
                                                MC7  376
      DATA CM4 /                                MC7  377
                                                MC7  378
                                                MC7  379
                                                MC7  380
                                                MC7  381
```

```
      DATA CMQ /                                        MC7  382
     .                                                  MC7  383
     .                                                  MC7  384
     .                                                  MC7  385
     .                                                  MC7  386
      DATA CLP /                                        MC7  387
     .                                                  MC7  388
     .                                                  MC7  389
     .                                                  MC7  390
     .                                                  MC7  391
      END                                               MC7  392
```

```
BLOCK DATA 8          74/74    OPT=1                          FTN 4.2+74355        07/07/76  11.03.49.      PAGE     4

         SYMBOLIC REFERENCE MAP (R=3)

VARIABLES      SN  TYPE              RELOCATION
     0  CLP        REAL        ARRAY      CLPFUN       REFS        2     DEFINED     120
     0  CL1        REAL        ARRAY      CLDFUN       REFS        2     DEFINED      75
     0  CL2        REAL        ARRAY      CL2FUN       REFS        2     DEFINED      45
     0  CL3        REAL        ARRAY      CL3FUN       REFS        2     DEFINED      50
   110  CL4        REAL        ARRAY      CLDFUN       REFS        2     DEFINED      90
    30  CL5        REAL        ARRAY      CLDFUN       REFS        2     DEFINED      80
    60  CL6        REAL        ARRAY      CLDFUN       REFS        2     DEFINED      85
     0  CM         REAL        ARRAY      CMFUN        REFS        2     DEFINED      23
     0  CMQ        REAL        ARRAY      CMQFUN       REFS        2     DEFINED     115
     0  CM1        REAL        ARRAY      CMDFUN       REFS        2     DEFINED      95
    30  CM2        REAL        ARRAY      CMDFUN       REFS        2     DEFINED     100
    60  CM3        REAL        ARRAY      CMDFUN       REFS        2     DEFINED     105
   110  CM4        REAL        ARRAY      CMDFUN       REFS        2     DEFINED     110
     0  CN         REAL        ARRAY      CZFUN        REFS        2     DEFINED      13
     0  CN1        REAL        ARRAY      CZDFUN       REFS        2     DEFINED      55
     0  CN2        REAL        ARRAY      CN2FUN       REFS        2     DEFINED      35
    60  CN3        REAL        ARRAY      CZDFUN       REFS        2     DEFINED      65
   110  CN4        REAL        ARRAY      CZDFUN       REFS        2     DEFINED      70
    30  CN5        REAL        ARRAY      CZDFUN       REFS        2     DEFINED      60
     0  CX         REAL        ARRAY      CXFUN        REFS        2     DEFINED       9
     0  CXO        REAL        ARRAY      CXOFUN       REFS        2     DEFINED      33
     0  CY2        REAL        ARRAY      CY2FUN       REFS        2     DEFINED      40
     0  DCM        REAL        ARRAY      DCMFUN       REFS        2     DEFINED      28
     0  DCN        REAL        ARRAY      DCZFUN       REFS        2     DEFINED      18

COMMON BLOCKS   LENGTH      MEMBERS - BIAS NAME(LENGTH)
      CXFUN         18                 0 CX      (18)
      CZFUN         24                 0 CN      (24)
      DCZFUN        24                 0 DCN     (24)
      CMFUN         24                 0 CM      (24)
      DCMFUN        24                 0 DCM     (24)
      CXOFUN         8                 0 CXO     (8)
      CN2FUN        24                 0 CN2     (24)
      CY2FUN        24                 0 CY2     (24)
      CL2FUN        24                 0 CL2     (24)
      CL3FUN        24                 0 CL3     (24)
      CZDFUN        96                 0 CN1     (24)            24 CN5     (24)               48 CN3     (24)
                                      72 CN4     (24)
      CMDFUN        96                 0 CM1     (24)            24 CM2     (24)               48 CM3     (24)
                                      72 CM4     (24)
      CLDFUN        96                 0 CL1     (24)            24 CL5     (24)               48 CL6     (24)
                                      72 CL4     (24)
      CMQFUN        24                 0 CMQ     (24)
      CLPFUN        24                 0 CLP     (24)

STATISTICS
  PROGRAM LENGTH                  0B        0
  CM LABELED COMMON LENGTH     1052B      554
```

```
      BLOCK DATA L                                                   MC7     393
      COMMON  /NTH/NTH(2)                                            MC7     394
     *        /THARG/THA(20)                                         MC7     395
     *        /THFUN/THF(20)                                         MC7     396
      DATA  NTH  /20,0/                                              MC7     397
      DATA  THA  /                                                   MC7     398
     *   0.,  .02,  .06,  .12, 1.20, 1.40, 1.52, 1.56, 1.60, 1.73,   MC7     399
     * 1.52, 1.90, 2.00, 2.20, 2.40, 2.60, 2.80, 3.60, 3.75, 100./   MC7     400
      DATA  THF  /                                                   MC7     401
     *                                                               MC7     402
     ,                                                               MC7     403
      END                                                            MC7     404
```

```
      BLOCK DATA L          74/74   OPT=1                                FTN 4.2+74355      07/07/75  11.03.51.      PAGE    2

      SYMBOLIC REFERENCE MAP (R=3)

  VARIABLES      SN  TYPE           RELOCATION
     0  NTH          INTEGER      ARRAY     NTH           REFS         2   DEFINED       5
     0  THA          REAL         ARRAY     THARG         REFS         2   DEFINED       6
     0  THF          REAL         ARRAY     THFUN         REFS         2   DEFINED       9

  COMMON BLOCKS   LENGTH      MEMBERS - BIAS NAME(LENGTH)
        NTH            2                0 NTH      (2)
        THARG         20                0 THA      (20)
        THFUN         20                0 THF      (20)

  STATISTICS
    PROGRAM LENGTH                    0B       0
    CM LABELED COMMON LENGTH         52B      42
```

```
SUBROUTINE RANNUM     74/74    OPT=1                    FTN 4.2+74353      07/07/75  11.03.52.      PAGE     1

              SUBROUTINE RANNUM(SN,START,RN)                             RAND04    2
              IF(START.EQ.0.) GO TO 10                                   RAND04    3
              CALL RANSET(START)                                         RAND04    4
              START=0.                                                   RAND04    5
        10    RN=RANF(DUM1)                                              RAND04    6
              IF(SN)20,30,40                                             RAND04    7
        20    RN=-RN                                                     RAND04    8
              RETURN                                                     RAND04    9
        30    RN=RANF(DUM2)*SIGN(1.,RANF(DUM3)-.5)                       RAND04   10
              RETURN                                                     RAND04   11
        40    CONTINUE                                                   RAND04   12
              RETURN                                                     RAND04   13
              END                                                        RAND04   14
```

```
SUBROUTINE RANNUM      74/74    OPT=1                              FTN 4.2+74353        07/07/76  11.03.52.        PAGE     2

         SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS        DEF LINE       REFERENCES
     3  RANNUM            1             8           10          12

 VARIABLES       SN  TYPE                RELOCATION
    34  DUM1      *  REAL          *UNDEF*                     REFS          5
    35  DUM2      *  REAL          *UNDEF                      REFS          3
    36  DUM3      *  REAL          *UNDEF                      REFS          9
     0  RN           REAL                        F.P.          REFS          7    DEFINED        1          5          7          9
     0  SN           REAL                        F.P.          REFS          6    DEFINED        1
     0  START        REAL                        F.P.          REFS          2          3    DEFINED        1          4

 EXTERNALS              TYPE     ARGS           REFERENCES
        RANSET                     1                 3

 INLINE FUNCTIONS      TYPE     ARGS          DEF LINE    REFERENCES
        RANF           REAL       1   INTRIN                    5          2*9
        SIGN           REAL       2   INTRIN                    9

 STATEMENT LABELS                       DEF LINE     REFERENCES
    12  10                                  5             2
     0  20                INACTIVE          7             6
    20  30                                  9             6
    27  40                                 11             6

 STATISTICS
   PROGRAM LENGTH                          37B         31
```

```
      SUBROUTINE NORMAL(RX,XL,XU,MU,SIGMA,DUMMY)
      DIMENSION FZ(126)
      REAL MU
      DATA DT,DT1,NTP,NPT,SQ2PI/.01,.04,126,0,.398942283/
      SL5=MU-5.*SIGMA
      SU5=MU+5.*SIGMA
      IF(XL.LT.SU5.AND.XU.GT.SL5) GO TO 10
      PRINT 901,SL5,SU5,XL,XU,MU,SIGMA
901   FORMAT(*1LIMITS FOR NORMAL DISTRIBUTION SHOULD BE BETWEEN*F10.2
     1       * AND*F10.2 * --- PROGRAM TERMINATED.*///*.XL =*F10.2,5X
     2       * XU =* F10.2,5X* MU =*F10.2,5X* SIGMA =*F10.2)
      STOP 123
10    IF(NPT.NE.0) GO TO 2
      T2=DT1
      FZ(1)=.5
      FC=FZ(1)
      T=0.
      FP=SQ2PI*EXP(-.5*T*T)
      DT2=DT*.5
      NPT=1
1     CONTINUE
      T=T+DT
      F=SQ2PI*EXP(-.5*T*T)
      FC=FC+DT2*(F+FP)
      FP=F
      IF(ABS(T-T2).GT..0001) GO TO 1
      NPT=NPT+1
      FZ(NPT)=FC
      T2=T2+DT1
      IF(NPT.LT.NTP) GO TO 1
2     CONTINUE
      RN=RANF(R)
      R=RN
      IF(RN.LT..5) R=1.-RN
      IF(R.GT.FZ(NPT)) GO TO 2
      DO 3 I=1,NPT
      IF(R.GT.FZ(I)) GO TO 3
      IF(I.EQ.1) GO TO 4
      X=I-1
      X=X*DT1
      X1=X-DT1
      RX=X1+(R-FZ(I-1))*DT1/(FZ(I)-FZ(I-1))
      GO TO 5
3     CONTINUE
      PRINT 100
100   FORMAT(13H0 ERROR DISRN)
      STOP
4     CONTINUE
      RX=0.
5     CONTINUE
      IF(RN.LT..5) RX=-RX
      RX=SIGMA*RX+MU
      IF(RX.GT.XU) GO TO 2
      IF(RX.LT.XL) GO TO 2
      RETURN
      END
```

```
      SUBROUTINE NORMAL      74/74   OPT=1                          FTN 4.2+74355        07/07/75  11.08.53.     PAGE    2

      SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS      DEF LINE     REFERENCES
    3 NORMAL           1            55

 VARIABLES       SN  TYPE              RELOCATION
   125  DT          REAL                              REFS        19        22     DEFINED        4
   126  DT1         REAL                              REFS        14        23        40         41        42
                                                   DEFINED         4
   207  DT2         REAL                              REFS        24     DEFINED      19
     0  DUMMY       REAL       *UNUSED      F.P.   DEFINED         1
   210  F           REAL                              REFS        24        25     DEFINED       23
   204  FC          REAL                              REFS        24        23     DEFINED       16        24
   206  FP          REAL                              REFS        24     DEFINED      18         25
   216  FZ          REAL       ARRAY                  REFS         2        16        35         37       3*42
                                                   DEFINED        15        23
   213  I           INTEGER                           REFS        37        33        39       3*42    DEFINED     36
     0  MU          REAL                    F.P.      REFS         3         5         6          8        52
                                                   DEFINED         1
   130  NPT         INTEGER                           REFS        13        27        28         38        35       36
                                                   DEFINED         4        28        27
   127  NTP         INTEGER                           REFS        30     DEFINED       4
   212  R           REAL                              REFS        32        35        37         42     DEFINED     33     34
   211  RN          REAL                              REFS        33      2*34        51     DEFINED       32
     0  RX          REAL                    F.P.      REFS        51        52        53         54     DEFINED      1     42
                                                      49          51        52
     0  SIGMA       REAL                    F.P.      REFS         5         5         8         52     DEFINED      1
   201  SLS         REAL                              REFS         7         3     DEFINED        5
   131  SQ2PI       REAL                              REFS        18        23     DEFINED        4
   202  SUS         REAL                              REFS         7         3     DEFINED        6
   205  T           REAL                              REFS      2*18        22      2*23         26     DEFINED     17     22
   203  T2          REAL                              REFS        26        23     DEFINED       14        29
   214  X           REAL                              REFS        40        41     DEFINED       39        48
     0  XL          REAL                    F.P.      REFS         7         3        34     DEFINED        1
     0  XU          REAL                    F.P.      REFS         7         9        53     DEFINED        1
   215  X1          REAL                              REFS        42     DEFINED      41

 FILE NAMES          MODE
      OUTPUT         FMT                    WRITES          8        45

 EXTERNALS              TYPE    ARGS        REFERENCES
      EXP               REAL      1 LIBRARY     18          23

 INLINE FUNCTIONS       TYPE    ARGS        DEF LINE   REFERENCES
      ABS               REAL      1  INTRIN                 26
      RANF              REAL      1  INTRIN                 32

 STATEMENT LABELS                DEF LINE     REFERENCES
    32  1                           21           26          38
    54  2                           31           13          35        53        54
   104  3                           44           36          37
   110  4                           48           38
   111  5                           50           43
    17  10                          13            7
   171  100        FMT              46           45
   143  901        FMT               9            8
```

```
      SUBROUTINE NORMAL      74/74    OPT=1                          FTN 4.2+74355        07/07/75  11.08.53.        PAGE       3

LOOPS  LABEL      INDEX        FROM-TO     LENGTH     PROPERTIES
   73  3        * I             38 44        13B         OPT       EXITS

STATISTICS
  PROGRAM LENGTH                  416B      270
```

```
      SUBROUTINE MCARLO(RNSTRT,MODE,ITSNOX)                             MCARLO    2
      COMMON /C/ C(3630)                                                MCARLO    3
      EQUIVALENCE (C(  60),    RLW)                                     MCARLO    4
      EQUIVALENCE (C(1561),    RSX)                                     MCARLO    5
      EQUIVALENCE (C(1571),    RSY)                                     MCARLO    6
      EQUIVALENCE (C(2000),      T)                                     MCARLO    7
      EQUIVALENCE (C(1564),YMC)                                         MCARLO    8
      EQUIVALENCE (C(1565),YMC2)                                        MCARLO    9
      EQUIVALENCE (C(1574),ZMC)                                         MCARLO   10
      EQUIVALENCE (C(1575),ZMC2)                                        MCARLO   11
      EQUIVALENCE (C(2664),     DT)                                     MCARLO   12
      EQUIVALENCE (C(2765),    NTM)                                     MCARLO   13
      EQUIVALENCE (C(2775),     TM)                                     MCARLO   14
      EQUIVALENCE (C(2785), TRMS2)                                      MCARLO   15
      EQUIVALENCE (C(2795),  TRMS)                                      MCARLO   16
      EQUIVALENCE (C(2805),    TMU)                                     MCARLO   17
      EQUIVALENCE (C(2815),    TVM)                                     MCARLO   18
      EQUIVALENCE (C(2825),  TSIG)                                      MCARLO   19
      EQUIVALENCE (C(3512), ISGCT)                                      MCARLO   20
      EQUIVALENCE (C(3514), SIGMA)                                      MCARLO   21
      EQUIVALENCE (C(3554), SIGLB)                                      MCARLO   22
      EQUIVALENCE (C(3594), SIGUB)                                      MCARLO   23
      EQUIVALENCE (C(3634), ISNOX)                                      MCARLO   24
      EQUIVALENCE (C(3674), IDIST)                                      MCARLO   25
      EQUIVALENCE (C(3511),RANSTT)                                      MCARLO   26
      EQUIVALENCE (C(3721),   ITCT)                                     MCARLO   27
      EQUIVALENCE (C(3723), TSGMA)                                      MCARLO   28
      EQUIVALENCE (C(3733),    TLB)                                     MCARLO   29
      EQUIVALENCE (C(3743),    TUB)                                     MCARLO   30
      EQUIVALENCE (C(3753), ITNOX)                                      MCARLO   31
      EQUIVALENCE (C(3763),ITDIST)                                      MCARLO   32
      EQUIVALENCE (C(3773), TSPER)                                      MCARLO   33
      EQUIVALENCE (C(3783),TYPPER)                                      MCARLO   34
      EQUIVALENCE (C(3793), TPSIG)                                      MCARLO   35
      EQUIVALENCE (C(3813),ITNOX2)                                      MCARLO   36
      EQUIVALENCE (C(3803), TNXST)                                      MCARLO   37
      DIMENSION SIGMA(40),SIGLB(40),SIGUB(40),ISNOX(40),IDIST(40)       MCARLO   38
      DIMENSION TSGMA(10),TLB(10),TUB(10),ITNOX(10),ITDIST(10),         MCARLO   39
     *TSPER(10),TYPPER(10),TPSIG(10),ITNOX2(10),TNXST(10)               MCARLO   40
      DIMENSION SVC(40),SVCT(40),IDISTT(7)                              MCARLO   41
      DIMENSION INIT(40)                                                MCARLO   42
      DIMENSION NTM(10), TM(10), TRMS2(10), TRMS(10), TMU(10), TVM(10), MCARLO   43
     1 TSIG(10)                                                         MCARLO   44
      DATA CPERTY/10HR          /                                       MCARLO   45
      DATA INIT/40*0/                                                   MCARLO   46
      DATA COEF1/13.0537351/                                            MCARLO   47
      DATA COEF2/165.4366343/                                           MCARLO   48
      DATA COEF3/23.10344002/                                           MCARLO   49
      DATA LTCT/0/                                                      MCARLO   50
      DATA (IDISTT(IA),IA=1,7)/6HNORMAL,7HUNIFORM,7H2-ORDER,7H2-ORDER,7H MCARLO   51
     *1-ORDER,7H2-ORDER,7H2-ORDER/                                      MCARLO   52
      RNSTRT = RANSTT                                                   MCARLO   53
      I = ITSNOX                                                        MCARLO   54
      IF(MODE.GE.2) GO TO 300                                           MCARLO   55
      IF(MODE.NE.-1) GO TO 81                                           MCARLO   56
      WRITE(6,2100)                                                     MCARLO   57
      WRITE(6,2103)                                                     MCARLO   58
```

```
      GO TO 1000
   81 CONTINUE
C
C                   MONTE CARLO INITIAL CONDITIONS.  USE UNIFORM
C                   DISTRIBUTION FOR I TH  CONDITION IF IDIST(I)=1,
C                   AND USE NORMAL DISTRIBUTION IF IDIST(I)=0.
C
C
C                   SAVE MEAN VALUES OF INITIAL CONDITIONS TO BE MONTE
C                   CARLO D   IN SVC(I), AND SAVE TIME SERIES MEAN
C                   VALUES (FOR CONSTANT MEANS) IN SVCT(I).
C
C
      IF(MODE.EQ.INIT(I)) GO TO 80
      JU = ISNDX(I)
      SVC(I) = C(JU)
      INIT(I) = 1
   80 CONTINUE
      IF(IDIST(I).NE.1) GO TO 100
      CALL RANNUM (1., RNSTRT, RX)
      JU = ISNDX(I)
      C(JJ) = SVC(I) + (RX*(SIGUB(I) - SIGLB(I)) + SIGLB(I))*SIGMA(I)
      GO TO 1
  100 IF(IDIST(I).NE.0) GO TO 101
      XL = SIGLB(I)
      SGMA=SIGMA(I)
      XU = SIGUB(I)
      JU = ISNDX(I)
      XMU=SVC(I)
      CALL NORM(RX,XL,XU,XMU,SGMA,RNSTRT)
      C(JJ)=RX
      GO TO 1
  101 JU= ISNDX(I)
      WRITE(6,5000)JU,IDIST(I)
    1 CONTINUE
      IF(IDIST(I).NE.1) GO TO 737
      WRITE(6,2101) JU, C(JU), SVC(I), SIGLB(I), SIGUB(I)
      GO TO 13
  737 WRITE(6,2105) JU, C(JU), SVC(I), SIGLB(I), SIGUB(I)
   13 CONTINUE
 5000 FORMAT(1X,61HTHE INITIAL CONDITION MONTE CARLO DIST. PARAMETER FOR
     * C-INDEX,1X,I5,1X,12HWAS INPUT AS,1X,I6,1X,30H...ONLY 0 AND 1 ARE
     *RECOGNIZED)
C
C
C                   WRITE OUT MONTE CARLO INITIAL CONDITIONS.
C
C
 2100 FORMAT(30X,30HMONTE CARLO INITIAL CONDITIONS/)
 2103 FORMAT(26X,7HC-INDEX,5X,8HMC-VALUE,5X,4HMEAN,5X,12HDISTRIBUTION,5X
     *,11HLOWER BOUND,5X,11HUPPER BOUND)
 2101 FORMAT(25X,I5,8X,F8.3,3X,F8.3,6X,7HUNIFORM,9X,F8.3,7X,F8.3)
 2105 FORMAT(25X,I5,8X,F11.7,1X,F11.7,1X,7H NORMAL,10X,F8.3,7X,F8.3)
C
      GO TO 1000
C
C
```

```
      C                                                                  MCARLO   116
      C               TEST FLIGHT TIME AGAINST NEXT SAMPLE TIME FOR      MCARLO   117
      C               EACH TIME SERIES ERROR SOURCE.  FOR THOSE TIME     MCARLO   118
      C               SERIES ERROR SOURCES HAVING A NEXT SAMPLING TIME,  MCARLO   119
      C               TNXST(I), LESS THAN OR EQUAL TO THE SIMULATION     MCARLO   120
      C               TIME, T, DETEEMINE THE TIME SERIES ERROR SOURCE    MCARLO   121
      C               MONTE CARLO VALUE.                                 MCARLO   122
      C                                                                  MCARLO   123
      C                                                                  MCARLO   124
  300 IF(ITCT.LE.0) GO TO 1000                                           MCARLO   125
      IF(MODE.EQ.4) TNXST(I) = 0.                                        MCARLO   126
      IF(C(1976).LE.0.) GO TO 1000                                       MCARLO   127
      IF(C(2000).LT.TNXST(ITSNDX)) GO TO 1000                            MCARLO   128
      IB= ITSNDX                                                         MCARLO   129
      ITT=ITDIST(IB) +1                                                  MCARLO   130
      C                                                                  MCARLO   131
      C                                                                  MCARLO   132
      C               DETERMINE IF THE TIME SERIES PERIOD IS DETERMINISTIC MCARLO 133
      C               (TYPPER(IB).GT.0) OR STOCHASTIC (TYPPER(IB).EQ.0).  MCARLO  134
      C                                                                  MCARLO   135
      C                                                                  MCARLO   136
      IF(TYPPER(IB).GT.0.) GO TO 311                                     MCARLO   137
      C                                                                  MCARLO   138
      C                                                                  MCARLO   139
      C               INCREMENT THE IB TH  TIME SERIES ERROR SOURCE BY   MCARLO   140
      C               THE VALUE OF THE DETERMINISTIC PERIOD, TSPER(IB)   MCARLO   141
      C                                                                  MCARLO   142
      C                                                                  MCARLO   143
      TNXST(IB)=C(2000)+ TSPER(IB)                                       MCARLO   144
      GO TO 312                                                          MCARLO   145
  311 XMU=TNXST(IB)+ TSPER(IB)                                           MCARLO   146
      XL=TNXST(IB)                                                       MCARLO   147
      XU=XMU+TSPER(IB)                                                   MCARLO   148
      SGMA=TPSIG(IB)                                                     MCARLO   149
      CALL NORM(RX,XL,XU,XMU,SGMA,RNSTRT)                                MCARLO   150
      C                                                                  MCARLO   151
      C                                                                  MCARLO   152
      C               INCREMENT THE IB TH   TIME SERIES ERROR SOURCE BY  MCARLO   153
      C               A NORMALLY DISTRIBUTED RANDOM VALUE, WHERE THE     MCARLO   154
      C               RANDOM VALUEIS BOUNDED TO  LIE BETWEEN ZERO AND    MCARLO   155
      C               TWICE THE PERIOD MEAN VALUE, TSPER(IB).            MCARLO   156
      C                                                                  MCARLO   157
      C                                                                  MCARLO   158
      TNXST(IB)=RX                                                       MCARLO   159
  312 CONTINUE                                                           MCARLO   160
      JU=ITNDX(IB)                                                       MCARLO   161
      JW=ITNDX2(IB)                                                      MCARLO   162
      IF(MODE.EQ.4) SVCT(I) = C(JU)                                      MCARLO   163
      XMU=SVOT(IB)                                                       MCARLO   164
      IF(JU.NE.JW) XMU=C(JU)                                             MCARLO   165
      XL=FLB(IB)                                                         MCARLO   166
      XU=TUB(IB)                                                         MCARLO   167
      SGMA=TSGMA(IB)                                                     MCARLO   168
 1306 IF(ITDIST(IB).LE.0) GO TO 1307                                     MCARLO   169
      GO TO (304,305,340,350,380,380),ITDIST(IB)                         MCARLO   170
      C                                                                  MCARLO   171
 1307 CONTINUE                                                           MCARLO   172
```

```
C
C                 DETERMINE THE NORMALLY DISTRIBUTED IB TH   ERRROR
C                 SOURCE MONTE CARLO VALUE.
C
C
      CALL NORM(RX,XL,XU,XMU,SGMA,RNSTRT)
      C(JW)=RX
      GO TO 309
C
  304 CONTINUE
C
C                 DETERMINE THE UNIFORMALY DISTRIBUTED IB TH  ERROR
C                 SOURCE MONTE CARLO VALUE.
C
C
      CALL RANNUM (1., RNSTRT, RX)
      ZMU=SVCT(IB)
      IF(JU.NE.JW) ZMU=C(JU)
      C(JW) = SVCT(IB) + (RX*(TUB(IB) - TLB(IB)) + TLB(IB)) *TSGMA(IB)
      GO TO 309
C
C
C                 DETERMINE THE CORRELATED NORMAL IB TH   ERROR SOURCE
C                 MONTE CALRLO VALUE.
C
C
  305 IF(MODE.NE.4) GO TO 330
      GO TO 1000
  330 CALL NORM(RSX,-3.,3.,0.,1.,RNSTRT)
      YMC = TMU(IB)
      YMC2 = TRMS(IB)
      GO TO 309
  340 IF(MODE.NE.4) GO TO 341
      GO TO 1000
  341 CALL NORM(RSY,-3.,3.,0.,1.,RNSTRT)
      ZMC = TMU(IB)
      ZMC2 = TRMS(IB)
      GO TO 309
  350 IF(MODE.NE.4) GO TO 351
      NTM(IB) = 0
      TM(IB) = 0.
      TRMS2(IB) = 0.
      GO TO 1000
  351 CALL NORM (RLW,-3.,3.,0.,1.,RNSTRT)
  309 CONTINUE
      NTM(IB) = NTM(IB) + 1
      TM(IB) = TM(IB) + C(JU)
      TRMS2(IB) = (TRMS2(IB) + C(JU)*C(JU))
C
C     CALCULATE TIME SERIES ROOT MEAN SQUARE
C
      TRMS(IB) = SQRT(TRMS2(IB)/NTM(IB))
C
C     CALCULATE TIME SERIES MEAN VALUES
C
      TMU(IB) = TM(IB)/NTM(IB)
      GO TO 1000
```

```
                ENTRY MCARLX                                                      MCARLO   230
                WRITE(6,7440)                                                     MCARLO   231
                DO 1001 I8=1,ITCT                                                 MCARLO   232
        C                                                                         MCARLO   233
        C       CALCULATE TIME SERIES VARIANCE                                    MCARLO   234
        C                                                                         MCARLO   235
                TVM(I8) = TRMS(I8)*TRMS(I8) - THU(I8)*THU(I8)                     MCARLO   236
        C                                                                         MCARLO   237
        C       CALCULATE TIME SERIES STANDARD DEVIATION                          MCARLO   238
        C                                                                         MCARLO   239
                TSIG(I8) = SQRT(TVM(I8))                                          MCARLO   240
        C                                                                         MCARLO   241
                WRITE(6,7443) ITNDX(I8),THU(I8),TVM(I8),TSIG(I8),TRMS(I8)         MCARLO   242
           1001 CONTINUE                                                          MCARLO   243
           7440 FORMAT(30X,30HMONTE CARLO TIME SERIES VALUES//,                   MCARLO   244
               1 26X,7HC-INDEX,5X,4HMEAN,8X,8HVARIANCE,4X,7HSTD DEV,5X,3HRMS/)    MCARLO   245
           7443 FORMAT(25X,I5,8X,F8.3,4X,F8.3,4X,F8.8,4X,F8.3)                    MCARLO   246
                GO TO 1000                                                        MCARLO   247
            380 WRITE(6,8821)ITDIST(I8)                                           MCARLO   248
           8821 FORMAT(1X,29HUNRECOGNIZED DISTRIBUTION NO.,1X,I6,1X,7HENTERED)    MCARLO   249
           1000 RETURN                                                            MCARLO   250
                END                                                               MCARLO   251
```

```
      SUBROUTINE MCARLO      74/74    OPT=1                          FTN 4.2+74355       07/07/75  11.05.10.      PAGE   6
CARD NR. SEVERITY  DETAILS     DIAGNOSIS OF PROBLEM
    235       I      ITCT      THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.
    239       I      ITCT      THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.
```

```
      SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE     REFERENCES
   3  MCARLO           1
 306  MCARLX         229        249

VARIABLES      SN  TYPE            RELOCATION
     0  C          REAL      ARRAY     C         REFS         2        3        4        5        6        7        8
                                                    9        10       11       12       13       14       15       16
                                                   17        18       19       20       21       22       23       24
                                                   25        26       27       28       29       30       31       32
                                                   33        34       35       36       73       94       96      126
                                                  127       143      162      164      189      210    2*219
                                              DEFINED        79       88      178      198
   410  COEF1    * REAL                       DEFINED        46
   411  COEF2    * REAL                       DEFINED        47
   412  COEF3    * REAL                       DEFINED        48
   407  CPERTY   * REAL                       DEFINED        44
  3147  DT         REAL                C         REFS        11
   573  I          INTEGER                       REFS        71       72       73       74       75       78     5*79
                                                   81        82       83       84       85       86       90       91
                                                   93      3*94     3*96      125      162  DEFINED       53
   602  IB         INTEGER                       REFS       129      135    2*143    2*145      146      147      148
                                                  158       160      161      163      165      166      167      168
                                                  169       188    5*190      201      202      207      208      211
                                                  212       213    2*217    2*218    2*219    3*223    3*227    5*235
                                                2*239     5*241      247  DEFINED      128      231
  7131  IDIST      INTEGER   ARRAY     C         REFS        24       37       76       81       91       93
   726  IDISTT     INTEGER   ARRAY               REFS        40  DEFINED       58
   735  INIT       INTEGER   ARRAY               REFS        41       71  DEFINED       45       74
  3667  ISSCT      INTEGER             C         REFS        19
  7061  ISNDX      INTEGER   ARRAY     C         REFS        23       37       72       78       85       90
  7210  ITCT       INTEGER             C         REFS        26      124      231
  7262  ITDIST     INTEGER   ARRAY     C         REFS        31       38      129      168      169      247
  7250  ITNDX      INTEGER   ARRAY     C         REFS        30       39      160      241
  7344  ITNDX2     INTEGER   ARRAY     C         REFS        35       38      161
     0  ITSNDX     INTEGER                F.P.   REFS        53      127      128  DEFINED        1
   603  ITT      * INTEGER                    DEFINED       129
   574  JU         INTEGER                       REFS        73       79       88       91     2*94     2*96      162
                                                2*164     2*189      213    2*219  DEFINED       72       78       85
                                                   90       160
   604  JH         INTEGER                       REFS       164      178      189      198  DEFINED      161
   413  LTST     * INTEGER                    DEFINED        49
     0  MODE       INTEGER                F.P.   REFS        54       55       71      125      162      198      204
                                                  210   DEFINED        1
  3314  NTM        INTEGER   ARRAY     C         REFS        12       42      217      223      227
                                              DEFINED       211      217
  3666  RANSTT     REAL                C         REFS        25       52
    73  REW        REAL                C         REFS         3      215
     0  RNSTRT     REAL                   F.P.   REFS        77       87      149      177      187      200      206
                                                  215   DEFINED        1       52
  3030  RSX        REAL                C         REFS         4      200
  3042  RSY        REAL                C         REFS         5      205
   575  RX         REAL                          REFS        77       79       87       88      149      158      177
                                                  170       187      190
   577  SGMA       REAL                          REFS        87      149      177  DEFINED       83      148      167
  3741  SIGLB      REAL      ARRAY     C         REFS        21       37     2*79       82       94       96
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        SUBROUTINE MCARLO      74/74    OPT=1                            FTN 4.2+74355      07/07/75  11.05.10.      PAGE     8

 VARIABLES       SN  TYPE            RELOCATION
  3671  SIGMA        REAL        ARRAY      C          REFS         20        37        79        83
  7011  SIGUB        REAL        ARRAY      C          REFS         22        37        79        84        94        96
   606  SVC          REAL        ARRAY                 REFS         40        79        86        94        96
                                                    DEFINED         73
   656  SVCT         REAL        ARRAY                 REFS         40       163       188       190   DEFINED       162
  3717  T            REAL                   C          REFS          6
  7224  TLS          REAL        ARRAY      C          REFS         20        39       165     2*190
  5326  TM           REAL        ARRAY      C          REFS         13        42       218       227   DEFINED       212       218
  5364  TMJ          REAL        ARRAY      C          REFS         16        42       201       207     2*235       241
                                                    DEFINED        227
  7332  TNXST        REAL        ARRAY      C          REFS         36        39       127       145       146
                                                    DEFINED        125       143       158
  7320  TPSIG        REAL        ARRAY      C          REFS         34        39       148
  5352  TRMS         REAL        ARRAY      C          REFS         15        42       202       208     2*235       241
                                                    DEFINED        223
  5340  TRMS2        REAL        ARRAY      C          REFS         14        42       219       223   DEFINED       213       219
  7212  TSGMA        REAL        ARRAY      C          REFS         27        39       167       190
  5410  TSIG         REAL        ARRAY      C          REFS         18        42       241   DEFINED       239
  7274  TSPER        REAL        ARRAY      C          REFS         32        38       143       145       147
  7236  TUB          REAL        ARRAY      C          REFS         29        38       166       190
  5376  TVM          REAL        ARRAY      C          REFS         17        42       239       241   DEFINED       235
  7306  TYPPER       REAL        ARRAY      C          REFS         33        38       136
   576  XL           REAL                              REFS         87       149       177   DEFINED        82       146       165
   601  XMJ          REAL                              REFS         87       147       149       177   DEFINED        86       145
                                                        163        164
   600  XU           REAL                              REFS         87       149       177   DEFINED        84       147       166
  3033  YMC          REAL                   C          REFS          7   DEFINED       201
  3034  YMC2         REAL                   C          REFS          8   DEFINED       202
  3045  ZMC          REAL                   C          REFS          9   DEFINED       207
  3046  ZMC2         REAL                   C          REFS         10   DEFINED       208
   605  ZMJ          REAL                           DEFINED        188       189

 FILE NAMES         MODE
        TAPE6       FMT                      WRITES        56        57        91        94        96       230       241       247

 EXTERNALS            TYPE    ARGS          REFERENCES
        NORM                    5                 87       149       177       203       206       215
        RANNUM                  3                 77       187
        SQRT        REAL        1 LIBRARY        223       239

 STATEMENT LABELS              DEF LINE     REFERENCES
    71  1                          92           80        89
   116  13                         97           95
    30  50                         75           71
    21  81                         59           55
    45  100                        81           76
    63  301                        90           81
   117  300                       124           54
   215  304                       181          159
   234  305                       198          169
   270  309                       216          179       191       203       209
   137  311                       145          136
   152  312                       159          144
   237  330                       200          198
   246  340                       204          169
   251  341                       206          204
   260  350                       210          159
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STATEMENT LABELS                 DEF LINE   REFERENCES
  265  351                          215        210
  342  380                          247        2*159
  105  737                           96         93
  346  1000                         249         58     112     124     125     127     199     205     214     228
                                               246
    0  1001                         242        231
    0  1306         INACTIVE        168
  207  1307                         171        168
  465  2100    FMT                  106         56
  504  2101    FMT                  109         94
  472  2103    FMT                  107         57
  512  2105    FMT                  110         96
  447  5000    FMT                   98         91
  534  7440    FMT                  243        230
  547  7443    FMT                  245        241
  560  3821    FMT                  248        247

LOOPS  LABEL    INDEX      FROM-TO     LENGTH     PROPERTIES
  320  1001     * 18       231 242     223                     EXT REFS

COMMON BLOCKS    LENGTH     MEMBERS - BIAS NAME(LENGTH)
   C             3830               0 C       (3830)

EQUIV CLASSES    LENGTH     MEMBERS - BIAS NAME(LENGTH)
C    C           3830             53 RLW    (1)         1560 RSX     (1)       1553 YMC     (1)
                               1564 YMC2    (1)         1570 RSY     (1)       1573 ZMC     (1)
                               1574 ZMC2    (1)         1999 T       (1)       2653 DT      (1)
                               2764 NTM     (10)        2774 TM      (10)      2734 TRMS2   (10)
                               2794 TRMS    (10)        2804 TMJ     (10)      2814 TVM     (10)
                               2824 TSIG    (10)        3510 RANSTT  (1)       3511 ISGCT   (1)
                               3513 SIGMA   (40)        3553 SISLB   (40)      3593 SIGJB   (40)
                               3633 ISNDX   (40)        3673 IDIST   (40)      3720 ITCT    (1)
                               3722 TSGMA   (10)        3732 TLB     (10)      3742 TUB     (10)
                               3752 ITNDX   (10)        3762 ITDIST  (10)      3772 TSPER   (10)
                               3782 TYPPER  (10)        3792 TPSIG   (10)      3802 TNXST   (10)
                               3812 ITNDX2  (10)

STATISTICS
  PROGRAM LENGTH                10058     517
  CM LABELED COMMON LENGTH      73668     3830
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SUBROUTINE CEPAS       74/74    OPT=1                          FTN 4.2+74355        07/07/75  11.05.18.        PAGE    1

                  SUBROUTINE CEPAS(NP,IBVNSW,IPLOT,XLAMBD,KSSIG,CEPSIG,PSIZE)    MCARLO   252
                  COMMON/CEPASS/X(100),Y(100)                                    MCARLO   253
                  DIMENSION               CEPSIG(6)                              MCARLO   254
                  DIMENSION CRIT(100)                                            MCARLO   255
                  REAL KSSIG                                                     MCARLO   256
                  INTEGER CEPSIG                                                 MCARLO   257
                  WRITE(6,2003)                                                  MCARLO   258
           2003   FORMAT(1H1,39HCEPAS PARAMETER CONTROL CARD INPUT DATA  )       MCARLO   259
                  WRITE(6,2004)NP,IBVNSW,IPLOT,XLAMBD,KSSIG,(CEPSIG(JJ),JJ=1,5)  MCARLO   260
                  WRITE(6,2005)                                                  MCARLO   261
           2005   FORMAT(1X,31HINPUT MISS DISTANCE COORDINATES///)               MCARLO   262
           2004   FORMAT(1X,3I6,2(1X,F10.3),5I6)                                 MCARLO   263
                  DO 5 I=1,5                                                     MCARLO   264
                  IF(CEPSIG(I).GT.0) GO TO 5                                     MCARLO   265
                  CEPSIG(I)= -1                                                  MCARLO   266
              5   CONTINUE                                                       MCARLO   267
                  NUC=(NP - 1) / 15                                              MCARLO   268
                  NUC=NUC+1                                                      MCARLO   269
                  WRITE(6,2000)                                                  MCARLO   270
           2000   FORMAT(1X,2HX=)                                                MCARLO   271
                  WRITE(6,2001)(X(I),I=1,NP)                                     MCARLO   272
           2001   FORMAT(10(2X,F7.3))                                            MCARLO   273
                  WRITE(6,2002)                                                  MCARLO   274
           2002   FORMAT(1X,2HY=)                                                MCARLO   275
                  WRITE(6,2001)(Y(I),I=1,NP)                                     MCARLO   276
                  CALL CEPP (X,Y,NP,KSSIG,XLAMBD,IBVNSW,CEPSIG,IPLOT,PSIZE)      MCARLO   277
                  RETURN                                                         MCARLO   278
                  END                                                            MCARLO   279
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     SUBROUTINE CEPAS      74/74   OPT=1                                  FTN 4.2+74.355     07/07/75  11.05.15.      PAGE     2

     SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS     DEF LINE     REFERENCES
    3  CEPAS          1            27

 VARIABLES      SN  TYPE            RELOCATION
     0  CEPSIG      INTEGER    ARRAY   F.P.        REFS        3        5        9       14       26
                                                 DEFINED        1       13
   161  CRIT        REAL      *UNDEF               REFS        4
   157  I           INTEGER                        REFS       14       13       21       25   DEFINED      13      21
                                                     25
     0  IBVNSW      INTEGER            F.P.        REFS        9       25  DEFINED        1
     0  IPLOT       INTEGER            F.P.        REFS        9       25  DEFINED        1
   156  JJ          INTEGER                        REFS        9  DEFINED        9
     0  KSSIG       REAL               F.P.        REFS        5        3       26  DEFINED        1
     0  NP          INTEGER            F.P.        REFS        9       17       21       25       26
                                                 DEFINED        1
   160  NUC         INTEGER                        REFS       18  DEFINED       17       18
     0  PSIZE       REAL               F.P.        REFS       26  DEFINED        1
     0  X           REAL       ARRAY   CEPASS      REFS        2       21       26
     0  XLAMBD      REAL               F.P.        REFS        9       25  DEFINED        1
   144  Y           REAL       ARRAY   CEPASS      REFS        2       25       26

 FILE NAMES        MODE
       TAPE5       FMT                         WRITES        7        9       18       19       21       23       25

 EXTERNALS              TYPE   ARGS         REFERENCES
       CEPP                      9              26

 STATEMENT LABELS                DEF LINE   REFERENCES
    17  5                           16         13       14
   134  2000      FMT               20         19
   142  2001      FMT               22         21       25
   150  2002      FMT               24         23
    75  2003      FMT                8          7
   125  2004      FMT               12          9
   117  2005      FMT               11         10

 LOOPS  LABEL     INDEX      FROM-TO      LENGTH     PROPERTIES
    15  5         I           13 16         38        INSTACK

 COMMON BLOCKS   LENGTH     MEMBERS - BIAS NAME(LENGTH)
       CEPASS      200                  0 X       (100)            100 Y       (100)

 STATISTICS
   PROGRAM LENGTH                  325B      213
   CM LABELED COMMON LENGTH        310B      200
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      SUBROUTINE CEPP(X,Y,NP,KSSIG,XLAMBD,IBVNSW,CEPSIG,IPLOT,PSIZE)    MCARLO    280
      REAL KSSIG                                                        MCARLO    281
      INTEGER CEPSIG                                                    MCARLO    282
      DIMENSION ZXX(100),ZYY(100)                                       MCARLO    283
      DIMENSION TITLE1(6),TITLE2(6)                                     MCARLO    284
      DIMENSION ICHI(6)                                                 MCARLO    285
      DIMENSION CHI2(6,50)                                              MCARLO    286
      DIMENSION X(100),Y(100),SORTX(100),DIST(100),CEPSIG(6),ICONREF(6), MCARLO   287
     * RCONF1(6),RCONF2(6)                                              MCARLO    288
      DATA ISKSW/0/                                                     MCARLO    289
      DATA (CHI2(1,I),I=1,50)/0.0201,0.297,0.872,1.65,2.56,3.57,4.66,   MCARLO    290
     *5.81,7.01,8.26,9.54,10.9,12.2,13.6,15.0,16.4,17.8,19.2,20.7,22.2, MCARLO    291
     *23.7,25.1,26.7,28.2,29.7,31.2,32.8,34.3,35.9,37.5,39.1,40.6,42.2, MCARLO    292
     *43.8,45.4,47.1,48.7,50.3,51.9,53.5,55.2,56.8,58.5,60.1,61.8,63.4, MCARLO    293
     *65.1,66.7,68.4,70.1/                                              MCARLO    294
      DATA (CHI2(2,I),I=1,50)/0.103,0.711,1.64,2.73,3.94,5.23,6.57,     MCARLO    295
     *7.95,9.39,10.9,12.3,13.8,15.4,16.9,18.5,20.1,21.7,23.3,24.9,26.5, MCARLO    296
     *28.1,29.8,31.4,33.1,34.8,36.4,38.1,39.8,41.5,43.2,44.9,46.6,48.3, MCARLO    297
     *50.0,51.7,53.5,55.2,56.9,58.7,60.4,62.1,63.9,65.6,67.4,69.1,70.9, MCARLO    298
     *72.6,74.4,76.2,77.9/                                              MCARLO    299
      DATA (CHI2(3,I),I=1,50)/0.211,1.06,2.20,3.49,4.87,6.3,7.79,9.31,  MCARLO    300
     *10.9,12.4,14.0,15.7,17.3,18.9,20.6,22.3,24.0,25.6,27.3,29.1,      MCARLO    301
     *30.8,32.5,34.2,35.9,37.7,39.4,41.2,42.9,44.7,46.5,48.2,50.0,51.8, MCARLO    302
     *53.5,55.3,57.1,58.9,60.7,62.5,64.3,66.1,67.9,69.7,71.5,73.3,75.1, MCARLO    303
     *76.9,78.7,80.5,82.4/                                              MCARLO    304
      DATA (CHI2(4,I),I=1,50)/0.446,1.65,3.07,4.59,6.18,7.81,9.4',11.2, MCARLO    305
     *12.9,14.6,16.3,18.1,19.8,21.6,23.4,25.1,25.9,28.7,30.5,32.3,34.2, MCARLO    306
     *36.0,37.8,39.6,41.4,43.3,45.1,47.0,48.8,50.6,52.5,54.3,56.2,58.0, MCARLO    307
     *59.9,61.8,63.6,65.5,67.3,69.2,71.1,72.9,74.8,76.7,78.6,80.4,82.3, MCARLO    308
     *84.2,86.1,87.9/                                                   MCARLO    309
      DATA (CHI2(5,I),I=1,50)/0.713,2.14,3.83,5.53,7.27,9.03,10.8,12.6, MCARLO    310
     *14.4,16.3,18.1,19.9,21.8,23.6,25.5,27.4,29.2,31.1,33.0,34.9,36.8, MCARLO    311
     *38.5,40.5,42.4,44.3,46.2,48.1,50.0,51.9,53.8,55.7,57.6,59.5,61.4, MCARLO    312
     *63.3,65.3,67.2,69.1,71.0,72.9,74.8,76.8,78.7,80.6,82.5,84.4,86.4, MCARLO    313
     *88.3,90.2,92.1/                                                   MCARLO    314
      DATA (TITLE1(I),I=1,6)/6HCEP CO,6HNFIDEN,6HCE CIR,5HCLE FO,       MCARLO    315
     1      5HR LAMB,5HDA =  /                                          MCARLO    316
      DATA (TITLE2(I),I=1,6)/6HCEP CO,6HNFIDEN,5HCE CIR,5HCLE FO,       MCARLO    317
     1      5HR LAMB,5HDA =  /                                          MCARLO    318
      DATA ICONREF/99,95,90,80,70/                                      MCARLO    319
      DATA SORTX/100*(0.)/                                              MCARLO    320
C                                                                       MCARLO    321
C  * * *  X= ARRAY OF X-COMPONENT OF MISS DISTANCES                     MCARLO    322
C  * * *  Y= ARRAY OF Y-COMPONENT OF MISS DISTANCES                     MCARLO    323
C  * * *  NP= NUMBER OF POINTS                                          MCARLO    324
C  * * *  KSSIG= SIGNIFICANCE LEVEL FOR K-S TEST DESIRED -- SET         MCARLO    325
C         NEGATIVE IF NO K-S TEST DESIRED                               MCARLO    326
C  * * *  XLAMBD= (PROGRAM CEP) / (MISSILE CEP) --                      MCARLO    327
C         SET TO ZERO IF NO ESTIMATE OF PROGRAM CEP IS MADE             MCARLO    328
C  * * *  IBVNSW=1 IF DESIRE TO USE BIVARIATE NORMAL ASSUMPTION         MCARLO    329
C         REGARDLESS OF OUTCOME OF K-S TEST ---  SET NOT = 1 TO USE     MCARLO    330
C         BIVARIATE NORMAL ONLY IF K-S TEST DOES NOT REJECT             MCARLO    331
C         ASSUMPTION OF NORMALITY.  IF NOT =1, AND DATA FAILS K-S TEST  MCARLO    332
C         FOR NORMALITY, CEP WILL BE                                    MCARLO    333
C         CALCULATED AS THE RADIUS, R, OF A CIRCLE CONTAINING           MCARLO    334
C         ONE-HALF OF THE SAMPLE POINTS.                                MCARLO    335
C  * * *  CEPSIG= SIGNIFICANCE LEVELS AT WHICH CEP CONFIDENCE           MCARLO    336
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      C           INTERVAL(S) PRINT IS DESIRED.    PRELOAD TO NEGATIVE NUMBERS  MCARLO    337
      C           IN CALLING PROGRAM BEFORE ENTERING DESIRED CONFIDENCE LEVELS  MCARLO    338
      C           ENTER AS AN INTEGER (IN PERCENT) -- EG., IF DESIRE            MCARLO    339
      C            R(0.99), R(0.90), AND R(0.70), ENTER (FOR EXAMPLE)           MCARLO    340
      C           CEPSIG(1=90, CEPSIG(2)=99, AND CEP(3)=70.  NO ORDER           MCARLO    341
      C           NEEDS TO BE OBSERVED.                                         MCARLO    342
      C   * * *   IPLOT= 1 FOR PLOTS OF CEP(S) AND POINTS, NOT =1 OTHERWISE     MCARLO    343
      C                                                                         MCARLO    344
            KSSIG=0.05                                                          MCARLO    345
            NCONF=0                                                             MCARLO    346
            EPSLN=.00001                                                        MCARLO    347
       8930 CONTINUE                                                            MCARLO    348
            WRITE(6,1019)                                                       MCARLO    349
       1019 FORMAT(1H1)                                                         MCARLO    350
            IF(NP.LE.0) GO TO 300                                               MCARLO    351
      C                                                                         MCARLO    352
      C   * * *   CALCULATE SAMPLE SIGMA-X, SIGMA-Y, X-MEAN, AND Y-MEAN         MCARLO    353
      C                                                                         MCARLO    354
            SUMX2=0.                                                            MCARLO    355
            SUMY2=0.                                                            MCARLO    356
            XBAR=0.                                                             MCARLO    357
            YBAR=0.                                                             MCARLO    358
            DO 1 I=1,NP                                                         MCARLO    359
            SUMX2=SUMX2 + X(I)**2                                               MCARLO    360
            SUMY2=SUMY2 + Y(I)**2                                               MCARLO    361
            XBAR=XBAR + X(I)                                                    MCARLO    362
          1 YBAR = YBAR + Y(I)                                                  MCARLO    363
            XBAR = XBAR / NP                                                    MCARLO    364
            YBAR = YBAR / NP                                                    MCARLO    365
            SXHAT2=(SUMX2 - (XBAR**2)*NP)/(NP - 1)                              MCARLO    366
            SYHAT2 = (SUMY2 - (YBAR**2)*NP)/(NP-1)                              MCARLO    367
            SXHAT= SQRT(SXHAT2)                                                 MCARLO    368
            SYHAT = SQRT(SYHAT2)                                                MCARLO    369
      C                                                                         MCARLO    370
      C                                                                         MCARLO    371
      C   * * *   KOLOMOGOROV-SMIRNOV TEST FOR NORMALITY                        MCARLO    372
      C                                                                         MCARLO    373
      C   * * *   CHECK X                                                       MCARLO    374
      C                                                                         MCARLO    375
      C                                                                         MCARLO    376
            NI=0                                                                MCARLO    377
            CALL KSTEST(X,NP,KSSIG,SBAR,SXHAT,NI)                               MCARLO    378
            NIX=NI                                                              MCARLO    379
      C                                                                         MCARLO    380
      C   * * *   CHECK Y                                                       MCARLO    381
      C                                                                         MCARLO    382
            CALL KSTEST(Y,NP,KSSIG,YBAR,SYHAT,NI)                               MCARLO    383
            NIY=NI                                                              MCARLO    384
            IF(NIX.GT.0) WRITE(6,1001)KSSIG                                     MCARLO    385
       1001 FORMAT(1X,60HX-COMPONENT OF MISS DISTANCE FAIL K-S TEST FOR NORMAL  MCARLO    386
           *ITY AT ,F10.5,2X,18HSIGNIFICANCE LEVEL)                             MCARLO    387
            WRITE(6,1078)                                                       MCARLO    388
            WRITE(6,1078)                                                       MCARLO    389
            IF(NIY.GT.0) WRITE(6,1002)KSSIG                                     MCARLO    390
       1002 FORMAT(1X,60HY-COMPONENT OF MISS DISTANCE FAIL K-S TEST FOR NORMAL  MCARLO    391
           *ITY AT ,F10.5,2X,18HSIGNIFICANCE LEVEL)                             MCARLO    392
            IF(IBVNSW.EQ.1) GO TO 450                                           MCARLO    393
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      IF(NIX.GT.0.OR.NIY.GT.0) GO TO 400
C
C  * * *  DETERMINE CONSTANT XK FOR ELLIPTICAL TO CEP CONVERSION
C
  450 SSMIN=AMIN1(SXHAT,SYHAT)
      SSMAX= AMAX1(SXHAT,SYHAT)
      RATIOX=SSMIN/SSMAX
      IF(RATIOX.GE.0.3) GO TO 102
      XK=0.9988*RATIOX**2 - 0.0496*RATIOX + 0.675
  103 CEP=XK*SSMAX
      GO TO 121
  102 CEP=0.615*SSMIN + 0.562*SSMAX
C
C  * * *  CALCULATE CONFIDENCE INTERVALS
C
      IF(NF.GT.1) GO TO 545
      WRITE(6,1078)
      WRITE(6,1078)
      WRITE(6,1112)NP
 1112 FORMAT(1X,64HNO CONFIDENCE INTERVALS CALCULATED BECAUSE NUMBER OF
     *POINTS, NP=,I6,14HIS LESS THAN 2)
      GO TO 528
  545 CONTINUE
  121 NCONF=0
      IF(CEPSIG(1).LE.0) GO TO 528
      DO 4 I=1,5
      ICHI(I)=-1
      IF(CEPSIG(I).LE.0) GO TO 4
      NCONF=NCONF + 1
      IF(CEPSIG(I).EQ.99)ICHI(I)=1
      IF(CEPSIG(I).EQ.95)ICHI(I)=2
      IF(CEPSIG(I).EQ.90)ICHI(I)=3
      IF(CEPSIG(I).EQ.80)ICHI(I)=4
      IF(CEPSIG(I).EQ.70)ICHI(I)=5
      IF(ICHI(I).GT.0) GO TO 44
      WRITE(6,1007)CEPSIG(I)
      NCONF=NCONF - 1
   44 IF(CEPSIG(I+1).LE.0) GO TO 526
    4 CONTINUE
 1007 FORMAT(1X,20HCONFIDENCE LEVEL OF ,I4,2X,28HENTERED WHICH IS NOT TA
     *BLED,2X,31HNO CONFIDENCE INTERVAL COMPUTED)
  526 CEPS=CEP
      NU=2*(NP - 1)
      NUS=NU
      NU=NU/2
      IF(NCONF.LE.0) GO TO 528
      DO 5 I=1,NCONF
      J=ICHI(I)
    5 KCONF1(I)=CEP*SQRT(NUS/CHI2(J,NU))
      IF(XLAMBD.LT.EPSLN) GO TO 528
  257 CEPS=CEP/SQRT(1+XLAMBD**2)
      IF(NCONF.LE.0) GO TO 528
      DO 6 I=1,NCONF
      J=ICHI(I)
    6 KCONF2(I)=KCONF1(I)/SQRT(1+(XLAMBD**2)*(1 - CHI2(J,NU)/NUS))
      WRITE(6,1078)
  528 WRITE(6,1010)CEP,NP
```

```
 1010 FORMAT(1X,10HJOINT CEP=,F7.3,2X,18HFOR THE FOLLOWING ,I4,1X,6HPOIN
     *TS)
      DO 8 I=1,NP
      DX=SQRT((X(I) - XBAR)**2 + (Y(I) - YBAR)**2)
    8 WRITE(6,1011)X(I),Y(I),DX
 1011 FORMAT(10X,1H(,F5.2,1H,,F5.2,1H),5X,10HMISS DIST=,F5.2)
      IF(NCONF.LE.0) GO TO 529
C
C
C
      WRITE(6,1078)
      WRITE(6,1078)
      WRITE(6,1012)
 1012 FORMAT(1X,36HCONFIDENCE INTERVAL(S) FOR JOINT CEP/)
      WRITE(6,1499)
 1499 FORMAT(42X,10H(PER CENT))
      WRITE(6,1013)(ICONREF(JJ),JJ=1,NCONF)
 1013 FORMAT(1X,20HCONFIDENCE LEVELS --,5(5X,I6))
      WRITE(6,1014)
 1014 FORMAT(21X,5(5X,6H------))
      WRITE(6,1015)(RCONF1(JJ),JJ=1,NCONF)
 1015 FORMAT(21X,5(5X,F6.2))
      WRITE(6,1500)
 1500 FORMAT(46X,4H(FT))
  529 IF(XLAMBD.LT.EPSLN) GO TO 500
      WRITE(6,1078)
      WRITE(6,1078)
 1078 FORMAT(130X)
      WRITE(6,1016)CEPS,XLAMBD
 1016 FORMAT(1X,12HMISSILE CEP=,F7.3,26H ASSUMING  SIMULATION CEP=,F6.2,
     *1X,21HTIMES THE MISSILE CEP)
  539 CONTINUE
      IF(NCONF.LE.0) GO TO 500
      WRITE(6,1078)
      WRITE(6,1078)
      WRITE(6,1017)
 1017 FORMAT(1X,38HCONFIDENCE INTERVAL(S) FOR MISSILE CEP/)
      WRITE(6,1499)
      WRITE(6,1013)(ICONREF(JJ),JJ=1,NCONF)
      WRITE(6,1014)
      WRITE(6,1015)(RCONF2(JJ),JJ=1,NCONF)
      WRITE(6,1500)
      GO TO 500
C
C
C
C
  530 CONTINUE
C
C
C  * * *  K-S TEST FOR NORMALITY WAS NEGATIVE, CALCULATE CEP AS THE
C         RADIUS OF A CIRCLE CONTAINING 50 PERCENT OF THE SAMPLE POINT
C
C
C
  400 DO 2 I=1,NP
    2 DIST(I)=SQRT((X(I)-XBAR)**2+(Y(I)-YBAR)**2)
```

```
      C                                                                 MCARLO   508
      C     * * *   SORT DISTANCES IN INCREASING ORDER                  MCARLO   509
      C                                                                 MCARLO   510
            ND=NP                                                       MCARLO   511
            ISV=0                                                       MCARLO   512
            NS=0                                                        MCARLO   513
        402 COMPR = 10**6                                               MCARLO   514
            DO 3 I=1,ND                                                 MCARLO   515
            IF(DIST(I).GE.COMPR) GO TO 3                                MCARLO   516
            ISV=I                                                       MCARLO   517
            COMPR=DIST(I)                                               MCARLO   518
          3 CONTINUE                                                    MCARLO   519
            NS=NS+1                                                     MCARLO   520
            SORTX(NS)=COMPR                                             MCARLO   521
            DIST(ISV)=DIST(ND)                                          MCARLO   522
            ND=ND-1                                                     MCARLO   523
            IF(ND.GT.1) GO TO 402                                       MCARLO   524
            NS=NS+1                                                     MCARLO   525
            SORTX(NS)=DIST(1)                                           MCARLO   526
      C                                                                 MCARLO   527
      C     * * *   DETERMINE IF NUMBER OF POINTS,NP, IS EVEN OR ODD    MCARLO   528
      C                                                                 MCARLO   529
            ND=NP/2                                                     MCARLO   530
            NS=NP-2*ND                                                  MCARLO   531
            IF(NS.EQ.0) GO TO 403                                       MCARLO   532
      C                                                                 MCARLO   533
      C     * * *   NUMBER OF POINTS IS EVEN.  SET CEP TO A DISTANCE WHICH IS   MCARLO   534
      C                                                                 MCARLO   535
      C             HALFWAY BETWEEN THE INTERIOR POINT CLOSEST TO THE 50 PER-   MCARLO   536
      C             CENT CIRCLE AND THE EXTERIOR POINT CLOSEST TO THE 50 PER-   MCARLO   537
      C             CENT CIRCLE.                                        MCARLO   538
      C                                                                 MCARLO   539
            CEP=(SORTX(ND)+SORTX(ND+1))/2.                              MCARLO   540
            GO TO 404                                                   MCARLO   541
      C                                                                 MCARLO   542
      C     * * *   NUMBER OF POINTS IS ODD.   SET CEP TO THE MEDIAN DISTANCE.  MCARLO   543
      C                                                                 MCARLO   544
        403 CEP=SORTX(ND+1)                                             MCARLO   545
        404 WRITE(6,1004)CEP                                            MCARLO   546
       1004 FORMAT(1X,4HCEP=,F10.5,2X,67HDATA FAILED K-S NORMALITY TEST -- NO  MCARLO   547
           *CONFIDENCE INTERVAL CALCULATED)                             MCARLO   548
            GO TO 500                                                   MCARLO   549
        300 WRITE(6,1000)                                               MCARLO   550
       1000 FORMAT(1X,42HSUBROUTINE CEP ENTERED WITH NO. POINTS = 0)    MCARLO   551
            GO TO 520                                                   MCARLO   552
      C                                                                 MCARLO   553
      C     * * *   PLOT CEP(S), CONFIDENCE INTERVALS, AND POINTS       MCARLO   554
      C                                                                 MCARLO   555
        500 DX=SQRT(XBAR**2 + YBAR**2)                                  MCARLO   556
            WRITE(6,1078)                                               MCARLO   557
            WRITE(6,1078)                                               MCARLO   558
            WRITE(6,1113)XBAR,YBAR,DX                                   MCARLO   559
       1113 FORMAT(1X,17HCEP CENTROID AT (,F5.3,1H,,F5.3,1H),10X,28HDISTANCE F MCARLO   560
           *ROM TARGET CENTER=,F6.3)                                    MCARLO   561
            IF(IPLOT.EQ.0) GO TO 520                                    MCARLO   562
            IF(NCONF.LE.0) GO TO 501                                    MCARLO   563
            DO 27 KOCH=1,NCONF                                          MCARLO   564
```

```
      JU=ICHI(KOCH)                                                     MCARLO   565
      DO 558 KMN=1,NP                                                   MCARLO   566
      ZXX(KMN)=X(KMN)                                                   MCARLO   567
  558 ZYY(KMN)=Y(KMN)                                                   MCARLO   568
      CALL PPLOT(ZXX,ZYY,NP,CEP,ICONREF(JU),RCONF1(KOCH),TITLE1,XBAR,   MCARLO   569
     *YBAR,0.,PSIZE)                                                    MCARLO   570
      IF(XLAMBD.LT.EPSLN) GO TO 27                                      MCARLO   571
      DO 557 KMN=1,NP                                                   MCARLO   572
      ZXX(KMN)=X(KMN)                                                   MCARLO   573
  557 ZYY(KMN)=Y(KMN)                                                   MCARLO   574
      CALL PPLOT(ZXX,ZYY,NP,CEPS,ICONREF(JU),RCONF2(KOCH),TITLE2,XBAR,  MCARLO   575
     *YBAR,XLAMBD,PSIZE)                                                MCARLO   576
   27 CONTINUE                                                          MCARLO   577
      GO TO 520                                                         MCARLO   578
  501 CALL PPLOT(X,Y,NP,CEP,0,0.,TITLE1,XBAR,YBAR,0.,PSIZE)             MCARLO   579
  520 CONTINUE                                                          MCARLO   580
      RETURN                                                            MCARLO   581
      END                                                               MCARLO   582
```

CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
40	I		DATA VARIABLE LIST EXCEEDS ITEM LIST. EXCESS VARIABLES NOT INITIALIZED.

```
      SUBROUTINE CEPP        74/74    OPT=1                                FTN 4.2+74355        07/07/75  11.05.22.        PAGE     8

         SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS      DEF LINE      REFERENCES
     3  CEPP            1          302

 VARIABLES        SN  TYPE              RELOCATION
   1317  CEP          REAL                                  REFS        156       163       155       171       267       290       300
                                                         DEFINED        124       126       251       266
   1320  CEPS         REAL                                  REFS        200       295   DEFINED       156       165
      0  CEPSIG       INTEGER      ARRAY       F.P.         REFS          3         8       139       142       144       145       146
                                                             147        148       150       152   DEFINED         1
   1667  CHI2         REAL         ARRAY                    REFS          7       163       169   DEFINED        11        16        21
                                                              26         31
   1331  COMPR        REAL                                  REFS        237       242   DEFINED       235       239
   2507  DIST         REAL         ARRAY                    REFS          8       237       239       243       247
                                                         DEFINED        228       243
   1324  DX           REAL                                  REFS        176       200   DEFINED       175       277
   1275  EPSLN        REAL                                  REFS        164       195       292   DEFINED        68
   1302  I            INTEGER                               REFS         81        82        83        84       141       142     2*144
                                                           2*145      2*146     2*147     2*148       149       150       152       162
                                                             163        168     2*169     2*175     2*176     3*228       237       238
                                                             239    DEFINED        80       140       161       167       174       227
                                                             236
      0  IBVNSW       INTEGER                  F.P.         REFS        114   DEFINED         1
   1661  ICHI         INTEGER      ARRAY                    REFS          6       143       162       168       286
                                                         DEFINED        141       144       145       146       147       148
   2653  ICONREF      INTEGER      ARRAY                    REFS          8       189       210       290       296
                                                         DEFINED         40
      0  IPLOT        INTEGER                  F.P.         REFS        283   DEFINED         1
    663  ISKSW     *  INTEGER                            DEFINED         10
   1327  ISV          INTEGER                               REFS        243   DEFINED       233       230
   1323  J            INTEGER                               REFS        163       169   DEFINED       162       168
   1325  JJ           INTEGER                               REFS        188       192       210       212   DEFINED       188       192
                                                             210        212
   1333  JU           INTEGER                               REFS        290       296   DEFINED       286
   1334  KMN          INTEGER                               REFS      2*288     2*289     2*294     2*295   DEFINED       287       293
   1332  KOSM         INTEGER                               REFS        286       290       296   DEFINED       285
      0  KSSIG        REAL                     F.P.         REFS          2        99       104       106       111
                                                         DEFINED          1        65
   1274  NCONF        INTEGER                               REFS        143       151       160       161       166       167       178
                                                             188        192       204       210       212       244       285
                                                         DEFINED         67       138       143       151
   1326  ND           INTEGER                               REFS        236       243       244       245       252     2*261       266
                                                         DEFINED        232       244       251
   1307  NI           INTEGER                               REFS         99       100       104       105   DEFINED        98
   1311  NIX          INTEGER                               REFS        106       115   DEFINED       100
   1312  NIY          INTEGER                               REFS        111       115   DEFINED       105
      0  NP           INTEGER                  F.P.         REFS         72        80        85        86      2*87      2*88        99
                                                             104        130       133       157       171       174       227       232
                                                             251        252       287       290       293       296       300
                                                         DEFINED          1
   1330  NS           INTEGER                               REFS        241       242       246       247       253
                                                         DEFINED        234       241       246       252
   1321  NJ           INTEGER                               REFS        158       159       163       169   DEFINED       157       159
   1322  NUS          INTEGER                               REFS        163       163   DEFINED       158
      0  PSIZE        REAL                     F.P.         REFS        290       296       300   DEFINED         1
   1315  RATIOX       REAL                                  REFS        122     2*123   DEFINED       121
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      SUBROUTINE CEPP        74/74    OPT=1                      FTN 4.2+74355      07/07/75  11.05.22.      PAGE     9

VARIABLES        SN  TYPE            RELOCATION
  2661  RCONF1       REAL        ARRAY                REFS         8       169       192       290   DEFINED     163
  2667  RCONF2       REAL        ARRAY                REFS         8       212       296   DEFINED       169
  1310  SBAR       * REAL                             REFS        99
  2343  SORTX        REAL        ARRAY                REFS         8     2*251       266   DEFINED        41       242       247
  1314  SSMAX        REAL                             REFS       121       124       126   DEFINED       120
  1313  SSMIN        REAL                             REFS       121       125   DEFINED       119
  1276  SUMX2        REAL                             REFS        81        87   DEFINED        76        81
  1277  SUMY2        REAL                             REFS        82        88   DEFINED        77        82
  1305  SXHAT        REAL                             REFS        99       119       120   DEFINED        89
  1303  SXHAT2       REAL                             REFS        89   DEFINED        87
  1306  SYHAT        REAL                             REFS       104       119       120   DEFINED        90
  1304  SYHAT2       REAL                             REFS        90   DEFINED        88
  1645  TITLE1       REAL        ARRAY                REFS         5       290       300   DEFINED        56
  1653  TITLE2       REAL        ARRAY                REFS         5       295   DEFINED        38
     0  X            REAL        ARRAY     F.P.       REFS         8        81        83        99       175       176       228
                                                       288       294       300   DEFINED         1
  1300  XBAR         REAL                             REFS        83        85        87       175       228       277       280
                                                       290       296       300   DEFINED        78        83        85
  1316  XK           REAL                             REFS       124   DEFINED       123
     0  XLAMBD       REAL                  F.P.       REFS       164       165       169       196       200       292       296
                                                    DEFINED        1
     0  Y            REAL        ARRAY     F.P.       REFS         8        82        84       104       175       176       228
                                                       289       295       300   DEFINED         1
  1301  YBAR         REAL                             REFS        84        86        88       104       175       228       277
                                                       280       290       296       300   DEFINED        79        84        86
  1335  ZXX          REAL        ARRAY                REFS         4       290       296   DEFINED       288       294
  1501  ZYY          REAL        ARRAY                REFS         4       290       296   DEFINED       289       295

FILE NAMES       MODE
      TAPE6      FMT                         WRITES        70       106       103       110       111       131       132       133
                                               150       170       171       175       182       183       184       186       188
                                               190       192       194       197       198       200       205       206       207
                                               209       210       211       212       213       267       274       278       279
                                               280

EXTERNALS             TYPE   ARGS          REFERENCES
      KSTEST                   0              99       104
      FPLOT                   11             290       296       300
      SQRT            REAL     1 LIBRARY      89        90       163       165       169       175       228       277

INLINE FUNCTIONS      TYPE   ARGS          DEF LINE  REFERENCES
      AMAX1           REAL     0  INTRIN              120
      AMIN1           REAL     0  INTRIN              119

STATEMENT LABELS                  DEF LINE    REFERENCES
     0  1                            34          30
     0  2                           228         227
   454  3                           240         236       237
   222  4                           153         140       142
     0  5                           163         161
     0  6                           169         157
     0  8                           176         174
   565  27                          298         285       292
   217  44                          152         149
   132  102                         126         122
     0  103           INACTIVE      124
   146  121                         138         125
```

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      SUBROUTINE CEPP        74/74    OPT=1                          FTN 4.2+74355       07/07/75  11.35.22.        PAGE   10

STATEMENT LABELS                     DEF LINE   REFERENCES
     0  257          INACTIVE          189
   502  300                            271         72
   423  400                            227        115
   442  402                            235        245
   475  403                            266        253
   477  404                            267        262
   116  450                            119        114
   505  500                            277        196       204       214       270
   570  501                            300        284
   577  520                            301        273       283       299
   225  525                            156        152
   277  528                            171        136       139       160       164       166
   357  529                            196        178
     0  530          INACTIVE          219
     0  539          INACTIVE          203
   146  545                            137        130
     0  557                            295        293
     0  558                            289        287
  1225  1000    FMT                    272        271
   675  1001    FMT                    107        106
   722  1002    FMT                    112        111
  1210  1004    FMT                    268        267
   766  1007    FMT                    154        150
  1011  1010    FMT                    172        171
  1026  1011    FMT                    177        176
  1045  1012    FMT                    185        184
  1065  1013    FMT                    189        188       210
  1075  1014    FMT                    191        190       211
  1104  1015    FMT                    193        192       212
  1132  1016    FMT                    201        200
  1155  1017    FMT                    208        207
   667  1019    FMT                     71         70
  1123  1078    FMT                    199        109       110       131       132       170       182       183       197       198
                                                  205       206       278       273
   747  1112    FMT                    134        133
  1247  1113    FMT                    281        280
  1056  1499    FMT                    107        106       209
  1112  1500    FMT                    195        194       213
     0  6950         INACTIVE           69

LOOPS  LABEL      INDEX       FROM-TO     LENGTH    PROPERTIES
   34  1          I            80 84        73B      INSTACK
  152  4        * I           140 153      539B                EXT REFS    EXITS
  235  5        * I           161 163      128B                EXT REFS
  260  6        * I           167 169      150B                EXT REFS
  302  8        * I           174 176      229B                EXT REFS
  424  2        * I           227 228      139B                EXT REFS
  451  3        * I           236 240       58B      INSTACK
  522  27       * KOCH        285 290      460B                EXT REFS  NOT INNER
  530  558        KMN         287 289       38B      INSTACK
  551  557        KMN         293 295       38B      INSTACK

STATISTICS
  PROGRAM LENGTH              27248    1492
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```
SUBROUTINE NORM        74/74    OPT=1                    FTN 4.2+74355       07/07/75  11.05.29.       PAGE      1

                  SUBROUTINE NORM(RX,XL,XU,XMU,SGMA,RNSTRT)                 MCARLO    583
                  XLL=XMU+SGMA*XL                                           MCARLO    584
                  XUU=XMU + SGMA*XU                                         MCARLO    585
                  CALL NORMAL(RX,XLL,XUU,XMU,SGMA,RNSTRT)                   MCARLO    586
                  RETURN                                                    MCARLO    587
                  END                                                       MCARLO    588
```

```
      SUBROUTINE NORM       74/74    OPT=1                      FTN 4.2+74355       07/07/75  11.05.29.       PAGE     2

      SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS      DEF LINE       REFERENCES
    3  NORM            1              5

 VARIABLES      SN  TYPE             RELOCATION
     0  RNSTRT      REAL                   F.P.      REFS        4    DEFINED       1
     0  RX          REAL                   F.P.      REFS        4    DEFINED       1
     0  SGMA        REAL                   F.P.      REFS        2       3          4    DEFINED       1
     0  XL          REAL                   F.P.      REFS        2    DEFINED       1
    30  XLL         REAL                             REFS        4    DEFINED       2
     0  XMJ         REAL                   F.P.      REFS        2       3          4    DEFINED       1
     0  XU          REAL                   F.P.      REFS        3    DEFINED       1
    31  XUU         REAL                             REFS        4    DEFINED       3

 EXTERNALS            TYPE    ARGS         REFERENCES
      NORMAL                    5               4

 STATISTICS
   PROGRAM LENGTH                   32B      26
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```
              SUBROUTINE KSTEST(Y,NP,KSSIG,XBAR,SXMAT,NI)                    MCARLO    589
              DIMENSION Y(100),CRIT(100),ISNIGF(100)                         MCARLO    590
              REAL KSSIG                                                     MCARLO    591
              DATA NZT/0/                                                    MCARLO    592
              DATA NUM/0/                                                    MCARLO    593
              DATA CRIT /975.,842.,708.,624.,565.,521.,486.,457.,432.,410.,391., MCARLO 594
             A          375.,361.,349.,338.,328.,318.,309.,301.,294.,287.,284., MCARLO 595
             B          280.,275.,270.,264.,258.,252.,248.,242.,238.,235.,234., MCARLO 596
             C          232.,230.,227.,224.,221.,218.,215.,212.,210.,207.,205., MCARLO 597
             D          203.,200.,198.,196.,194.,192.,50*192./              MCARLO    598
              NV=NP                                                          MCARLO    599
              NI=0                                                           MCARLO    600
              RSNIG=KSSIG                                                    MCARLO    601
              NZT=5                                                          MCARLO    602
         3011 CONTINUE                                                       MCARLO    603
              NSG=0                                                          MCARLO    604
          500 FORMAT(I2)                                                     MCARLO    605
              NUM=NUM+1                                                      MCARLO    606
          527 RNV=NV                                                         MCARLO    607
              YMAX=Y(1)                                                      MCARLO    608
              YS2=Y(1)**2                                                    MCARLO    609
              YMIN=Y(1)                                                      MCARLO    610
              YSUM=Y(1)                                                      MCARLO    611
              DO 1 I=2,NV                                                    MCARLO    612
              IF(YMAX-Y(I))100,100,101                                       MCARLO    613
          100 YMAX=Y(I)                                                      MCARLO    614
          101 IF(YMIN-Y(I))106,106,102                                       MCARLO    615
          102 YMIN=Y(I)                                                      MCARLO    616
          106 YSUM=YSUM+Y(I)                                                 MCARLO    617
            1 YS2=YS2+Y(I)**2                                                MCARLO    618
              RNV1=RNV-1                                                     MCARLO    619
              S2=(YS2-(YSUM**2)/RNV)/RNV1                                    MCARLO    620
              S=SQRT(S2)                                                     MCARLO    621
              YMEAN=YSUM/RNV                                                 MCARLO    622
              WRITE(6,563)NUM                                                MCARLO    623
          563 FORMAT(1X,9HCASE NO.=,I4/)                                     MCARLO    624
              WRITE(6,517)YMEAN,S                                            MCARLO    625
          517 FORMAT(11X,5HMEAN=,F10.4,8HSTD DEV=,F10.4)                     MCARLO    626
              NSTEPS = NV/5                                                  MCARLO    627
              SSTEP=(YMAX-YMIN)/NSTEPS                                       MCARLO    628
              B1=YMIN-SSTEP                                                  MCARLO    629
              NCUM=0                                                         MCARLO    630
              DMAX=0.                                                        MCARLO    631
              WRITE(6,4331)NSTEPS,YMIN,YMAX                                  MCARLO    632
         4331 FORMAT(1X,7HNSTEPS=,I5,2X,5HYMIN=,F6.3,1X,5HYMAX=,F6.3)        MCARLO    633
              DO 2 I=1,NSTEPS                                                MCARLO    634
              B1=B1+SSTEP                                                    MCARLO    635
          124 OBS=B1+SSTEP                                                   MCARLO    636
          125 B2=B1+SSTEP                                                    MCARLO    637
              IF(I.EQ.NSTEPS) B2=B2+0.00001                                  MCARLO    638
              NN=0                                                           MCARLO    639
              DO 2 J=1,NV                                                    MCARLO    640
              IF(Y(J)-B1)3,103,103                                           MCARLO    641
          103 IF(Y(J)-B2)104,3,3                                             MCARLO    642
          104 NN=NN+1                                                        MCARLO    643
              NCUM=NCUM+1                                                    MCARLO    644
            3 CONTINUE                                                       MCARLO    645
```

```
          RNCUM=NCUM                                                  MCARLO   646
          RELCUM=RNCUM/RNV                                            MCARLO   647
          YMINUSN=OBS-YMEAN                                           MCARLO   648
          Z=YMINUSN/S                                                 MCARLO   649
          CALL ZTABLE(Z,FREQ,NZT)                                     MCARLO   650
          D=ABS(FREQ-RELCUM)                                          MCARLO   651
          IF(D-DMAX)120,120,121                                       MCARLO   652
      121 DMAX=D                                                      MCARLO   653
      120 CONTINUE                                                    MCARLO   654
        2 CONTINUE                                                    MCARLO   655
          CRITTT = CRIT(NV)/1000.                                     MCARLO   656
          WRITE(6,6123)DMAX,CRITTT                                    MCARLO   657
     6123 FORMAT(1X,5HDMAX=,F10.7,2X,13HCRITICAL VAL=,F10.7)          MCARLO   658
          IF(DMAX-CRITTT)566,568,568                                  MCARLO   659
      568 NSG=NSG+1                                                   MCARLO   660
      516 CONTINUE                                                    MCARLO   661
          NI=1                                                        MCARLO   662
      566 CONTINUE                                                    MCARLO   663
          RETURN                                                      MCARLO   664
          END                                                         MCARLO   665
```

```
        SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS      DEF LINE      REFERENCES
    3  KSTEST          1            76

 VARIABLES       SN  TYPE              RELOCATION
   245  B1          REAL                            REFS        47       48        49       53    DEFINED      41      47
   251  B2          REAL                            REFS        50       54   DEFINED       49       50
   263  CRIT        REAL        ARRAY               REFS         2       63   DEFINED        6
   262  CRITTT      REAL                            REFS        69       71   DEFINED       68
   261  D           REAL                            REFS        64       65   DEFINED       63
   247  DMAX        REAL                            REFS        64       63        71  DEFINED       43      65
   260  FREQ        REAL                            REFS        62       63
   236  I           INTEGER                         REFS        25       25        27       28       29      30      50
                                                 DEFINED        24       46
   427  ISNIGF      INTEGER   *UNDEF                REFS         2
   253  J           INTEGER                         REFS        53       54   DEFINED       52
     0  KSSIG       REAL                  F.P.      REFS         3       13   DEFINED        1
   246  NCUM        INTEGER                         REFS        56       58   DEFINED       42       56
     0  N1          INTEGER               F.P.   DEFINED         1       12        74
   252  NN          INTEGER                         REFS        55  DEFINED        51       55
     0  NP          INTEGER               F.P.      REFS        11  DEFINED         1
   230  NSS         INTEGER                         REFS        72  DEFINED        16       72
   243  NSTEPS      INTEGER                         REFS        40       44        46       58    DEFINED      39
   151  NUM         INTEGER                         REFS        18       35   DEFINED        5       19
   226  NV          INTEGER                         REFS        19       24        39       52       68
                                                 DEFINED        11
   150  NZT         INTEGER                         REFS        62  DEFINED         4       14
   250  OBS         REAL                            REFS        60  DEFINED        48
   255  RELCUM      REAL                            REFS        63  DEFINED        59
   254  RNCUM       REAL                            REFS        59  DEFINED        58
   231  RNV         REAL                            REFS        31       32        34       59    DEFINED      19
   237  RNV1        REAL                            REFS        32  DEFINED        31
   227  RSNIG     * REAL                         DEFINED        13
   241  S           REAL                            REFS        37       61   DEFINED       33
   244  SSTEP       REAL                            REFS        41       47        48       49    DEFINED      40
     0  SXMAT       REAL      *UNUSED     F.P.   DEFINED         1
   240  S2          REAL                            REFS        33  DEFINED        32
     0  XBAR        REAL      *UNUSED     F.P.   DEFINED         1
     0  Y           REAL        ARRAY     F.P.      REFS         2       20        21       22       23      25      26
                                                      27        28       29        30       53       54
                                                 DEFINED         1
   232  YMAX        REAL                            REFS        25       40        44  DEFINED       20      26
   242  YMEAN       REAL                            REFS        37       60   DEFINED       34
   234  YMIN        REAL                            REFS        27       40        41       44    DEFINED      22      28
   256  YMINUSN     REAL                            REFS        61  DEFINED        60
   235  YSUM        REAL                            REFS        29       32        34  DEFINED       23      29
   233  YS2         REAL                            REFS        30       32   DEFINED       21       38
   257  Z           REAL                            REFS        62  DEFINED        61

 FILE NAMES       MODE
      TAPE6      FMT                     WRITES       35        37       44        69

 EXTERNALS            TYPE   ARGS        REFERENCES
      SQRT           REAL      1 LIBRARY      33
      ZTABLE                   3              62
```

```
      SUBROUTINE KSTEST       74/74    OPT=1                                FTN 4.2+74335        07/07/75  11.05.30.        PAGE     4

  INLINE FUNCTIONS    TYPE    ARGS          DEF LINE   REFERENCES
      ABS             REAL       I  INTRIN                  63

  STATEMENT LABELS                  DEF LINE    REFERENCES
      0   1                             30         24
      0   2                             67         46          52
    107   3                             57         53         2*54
      0   100          INACTIVE         26        2*25
     30   101                           27         25
      0   102          INACTIVE         28         27
      0   103          INACTIVE         54        2*53
      0   104          INACTIVE         55         54
     33   105                           29        2*27
    125   120                           66        2*64
      0   121          INACTIVE         65         64
      0   124          INACTIVE         48
      0   125          INACTIVE         49
    152   500     FMT   NO REFS         17
      0   515          INACTIVE         73
    170   517     FMT                   38         37
      0   527          INACTIVE         19
    160   563     FMT                   36         35
    143   565                           75         71
      0   568          INACTIVE         72        2*71
      0   3011         INACTIVE         15
    203   4331    FMT                   45         44
    216   6123    FMT                   70         69

  LOOPS   LABEL     INDEX      FROM-TO      LENGTH     PROPERTIES
     25   1           I        24  30        128         OPT
     66   2        *  I        46  67        443                   EXT REFS   NOT INNER
     77   2        *  J        52  67        318                   EXT REFS

  STATISTICS
    PROGRAM LENGTH                  5738      379
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```
      SUBROUTINE ZTABLE(Z,FREQ,NZT)                                      MCARLO   666
      DIMENSION ZCUM(385)                                                MCARLO   667
      DATA (ZCUM(I),I=1,108)                                             MCARLO   668
     1         /0000.,0040.,0080.,0120.,0160.,0199.,0239.,0279.,0319.,   MCARLO   669
     A          0359.,0398.,0438.,0478.,0517.,0557.,0596.,0636.,0675.,   MCARLO   670
     B          0714.,0753.,0793.,0832.,0871.,0910.,0948.,0987.,1026.,   MCARLO   671
     C          1064.,1103.,1141.,1179.,1217.,1255.,1293.,1331.,1368.,   MCARLO   672
     D          1406.,1443.,1480.,1517.,1554.,1591.,1682.,1664.,1700.,   MCARLO   673
     E          1736.,1772.,1808.,1844.,1879.,1915.,1950.,1985.,2019.,   MCARLO   674
     F          2054.,2088.,2123.,2157.,2190.,2224.,2257.,2291.,2324.,   MCARLO   675
     G          2357.,2389.,2422.,2452.,2486.,2517.,2549.,2580.,2611.,   MCARLO   676
     H          2642.,2673.,2704.,2734.,2764.,2794.,2823.,2852.,2881.,   MCARLO   677
     I          2910.,2939.,2967.,2995.,3023.,3051.,3079.,3106.,3133.,   MCARLO   678
     J          3159.,3186.,3212.,3238.,3264.,3289.,3315.,3340.,3365.,   MCARLO   679
     K          3389.,3413.,3138.,3461.,3485.,3508.,3531.,3554.,3577./   MCARLO   680
      DATA (ZCUM(I),I=109,216)                                           MCARLO   681
     2         /3599.,3621.,3643.,3665.,3686.,3708.,3729.,3749.,3770.,   MCARLO   682
     A          3790.,3810.,3830.,3849.,3869.,3888.,3907.,3925.,3944.,   MCARLO   683
     B          3962.,3980.,3997.,4015.,4032.,4049.,4065.,4082.,4099.,   MCARLO   684
     C          4115.,4131.,4147.,4162.,4177.,4192.,4207.,4222.,4236.,   MCARLO   685
     D          4251.,4265.,4279.,4292.,4306.,4319.,4332.,4345.,4357.,   MCARLO   686
     E          4370.,4382.,4394.,4406.,4418.,4429.,4441.,4452.,4463.,   MCARLO   687
     F          4474.,4484.,4495.,4505.,4515.,4525.,4535.,4545.,4554.,   MCARLO   688
     G          4564.,4573.,4582.,4591.,4599.,4608.,4616.,4625.,4833.,   MCARLO   689
     H          4641.,4649.,4656.,4664.,4671.,4678.,4686.,4693.,4699.,   MCARLO   690
     I          4706.,4713.,4719.,4726.,4732.,4738.,4744.,4750.,4756.,   MCARLO   691
     J          4761.,4767.,4772.,4778.,4783.,4788.,4793.,4798.,4803.,   MCARLO   692
     K          4808.,4812.,4817.,4821.,4826.,4830.,4834.,4838.,4842./   MCARLO   693
      DATA (ZCUM(I),I=217,385)                                           MCARLO   694
     3         /4846.,4850.,4854.,4857.,4861.,4864.,4868.,4871.,4875.,   MCARLO   695
     A          4878.,4881.,4884.,4887.,4890.,4893.,4896.,4898.,4901.,   MCARLO   696
     B          4904.,4906.,4909.,4911.,4913.,4916.,4918.,4920.,4922.,   MCARLO   697
     C          4925.,4927.,4929.,4931.,4932.,4934.,4936.,4938.,4940.,   MCARLO   698
     D          4941.,4943.,4945.,4946.,4948.,4949.,4951.,4952.,4953.,   MCARLO   699
     E          4955.,4956.,4957.,4959.,4960.,4961.,4962.,4963.,4964.,   MCARLO   700
     F          4965.,4966.,4967.,4968.,4969.,4970.,4971.,4972.,4973.,   MCARLO   701
     G          4974.,4974.,4975.,4976.,4977.,4977.,4978.,4979.,4979.,   MCARLO   702
     H          4980.,4981.,4981.,4982.,4982.,4983.,4984.,4984.,4985.,   MCARLO   703
     I          4985.,4986.,4986.,4987.,4987.,4987.,4988.,4988.,4989.,   MCARLO   704
     J          4989.,4989.,4990.,4990.,75*4990./                        MCARLO   705
  107 ABSZ=ABS(Z)                                                        MCARLO   706
      EPSLN1=-0.005                                                      MCARLO   707
      EPSLN2=0.005                                                       MCARLO   708
      IF(Z-EPSLN1)110,111,111                                            MCARLO   709
  111 IF(Z-EPSLN2)112,112,110                                            MCARLO   710
  112 FREQ=0.5                                                           MCARLO   711
      GO TO 200                                                          MCARLO   712
  110 ABSZ=100.*ABSZ                                                     MCARLO   713
      IZ=ABSZ                                                            MCARLO   714
      RZ=IZ                                                              MCARLO   715
      RZ=RZ+0.5                                                          MCARLO   716
      IF(ABSZ-RZ)101,101,102                                             MCARLO   717
  102 IZ=IZ+1                                                            MCARLO   718
  101 IF(IZ-310)103,104,104                                              MCARLO   719
  104 FREQ=1.                                                            MCARLO   720
      IF(Z.LE.0.)FREQ=0.                                                 MCARLO   721
      GO TO 200                                                          MCARLO   722
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  103 IZ=IZ+1                                    MCARLO   723
      FREQ = ZCUM(IZ)/10000.                     MCARLO   724
      IF(Z-0.)105,105,106                        MCARLO   725
  105 FREQ=0.5-FREQ                              MCARLO   726
      GO TO 200                                  MCARLO   727
  106 FREQ=FREQ+0.5                              MCARLO   728
  200 RETURN                                     MCARLO   729
      END                                        MCARLO   730
```

```
SUBROUTINE ZTABLE      74/74    OPT=1                          FTN 4.2+74355      07/07/75  11.05.31.      PAGE    3

SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE      REFERENCES
   3  ZTABLE          1          64

VARIABLES       SN  TYPE            RELOCATION
   60  ABSZ         REAL                               REFS          43        43        52   DEFINED      41       40
   61  EPSLN1       REAL                               REFS          44   DEFINED        42
   62  EPSLN2       REAL                               REFS          45   DEFINED        43
    0  FREQ         REAL                  F.P.         REFS          61        63   DEFINED        1       46       55       56
                                                         59          61        63
   63  IZ           INTEGER                            REFS          50        53        54       58       59
                                                    DEFINED          49        53        58
    0  NZT          INTEGER   *UNUSED     F.P.      DEFINED           1
   64  RZ           REAL                               REFS          51        52   DEFINED       50       51
    0  Z            REAL                  F.P.         REFS          41        44        45       56       60
                                                    DEFINED           1
   65  ZCOM         REAL        ARRAY                  REFS           2        59   DEFINED        3       15       29

INLINE FUNCTIONS     TYPE    ARGS         DEF LINE   REFERENCES
      ABS            REAL      1   INTRIN                41

STATEMENT LABELS                DEF LINE     REFERENCES
   26  101                           54        2*52
    0  102          INACTIVE         53          52
   36  103                           58          54
    0  104          INACTIVE         55        2*54
    0  105          INACTIVE         61        2*60
   46  106                           63          60
    0  107          INACTIVE         41
   16  110                           48          44          45
    0  111          INACTIVE         45        2*44
    0  112          INACTIVE         46        2*45
   51  200                           64          47          57          62

STATISTICS
  PROGRAM LENGTH               666B         438
```

```
      SUBROUTINE PPLOT(X,Y,NP,CEP,ICHI,RCONF,TITLE,XBAR,YBAR,XLAMBD,
     1              PSIZE)
      DIMENSION X(100),Y(100),TITLE(6),SORTY(100),SORTX(100),PLINE(22)
      DIMENSION MSKK(20)
      DATA POINTS/7HX      /
      DATA CEPX/7H......./
      DATA CONFC/7H......./
      DATA EPSLN/0.00001/
      DATA (PLINE(I),I=1,22)/22*(7H       )/
      DATA PP/7HXXXXXXX/
      DATA CPR/7H......./
      DATA RCR/7H......./
      DATA TGT/7HTTTTTTT/
      DATA CPCEN/7HCCCCCCC/
      DATA BLNKK/7H       /
      DATA (MSKK(I),I=1,10)/77000000000000000000B,00770000000000000000B,
     *00007700000000000000B,00000077000000000000B,00000000770000000000B,
     *00000000007700000000B,00000000000077000000B,00000000000000770000B,
     *00000000000000007700B,00000000000000000077B/
      ICIKSW=0
      ITGTSW=0
      YCEP=CEP
      YRCNF=RCONF
      WRITE(6,1000)
 1000 FORMAT(1H1)
      WRITE(6,1001) (TITLE(I),I=1,6),XLAMBD
 1001 FORMAT(46X,6A6,F4.2)
      WRITE(6,1003)
      WRITE(6,1002)POINTS
      WRITE(6,1072)CEPX
      CPCCC=CPCEN.A.MSKK(4).O.BLNKK.A..N.MSKK(4)
      WRITE(6,1492)CPCCC
 1492 FORMAT(6X,16HCIRCLE CENTROID ,A7)
      CPCCC=TGT.A.MSKK(4).O.BLNKK.A..N.MSKK(4)
      WRITE(6,1493)CPCCC
 1493 FORMAT(6X,10HTGT CENTER,A7)
 1002 FORMAT(6X,9HPOINTS   ,A6)
 1003 FORMAT(130X)
 1072 FORMAT(6X,10HCEP CIRCLE,3X,A6)
      IF(ICHI.LE.0) GO  TO 100
      WRITE(6,1073)ICHI,CONFC
  100 CONTINUE
      DO 1 I=1,3
    1 WRITE(6,1003)
 1073 FORMAT(1X,I4,1X,26HPER CENT CONFIDENCE CIRCLE,3X,A6)
      NO=NP
      NS=0
      XMIN=1.*(10**6)
      XMAX=1.*(-10**6)
  103 YMAX=1.*(-10**6)
      DO 2 I=1,NO
      IF(Y(I).LE.YMAX) GO TO 101
      YMAX = Y(I)
      IY=I
  101 IF(NO.NE.NP) GO TO 2
      IF(X(I).GT.XMAX) XMAX=X(I)
      IF(X(I).LT.XMIN) XMIN=X(I)
```

```
    2 CONTINUE                                                        MCARLO   788
      NS=NS+1                                                         MCARLO   789
      SORTY(NS)=Y(IY)                                                 MCARLO   790
      Y(IY)=Y(ND)                                                     MCARLO   791
      SORTX(NS)=X(IY)                                                 MCARLO   792
      X(IY)=X(ND)                                                     MCARLO   793
      ND=ND-1                                                         MCARLO   794
      IF(ND.GT.1) GO TO 103                                           MCARLO   795
      NS=NS+1                                                         MCARLO   796
      SORTY(NS)=Y(1)                                                  MCARLO   797
      SORTX(NS)=X(1)                                                  MCARLO   798
      XMAXA = ABS(XMAX)                                               MCARLO   799
      XMINA=ABS(XMIN)                                                 MCARLO   800
      XDEVM=AMAX1(XMAXA,XMINA)                                        MCARLO   801
      YMAXA=ABS(SORTY(1))                                             MCARLO   802
      YMINA=ABS(SORTY(NP))                                            MCARLO   803
      YDEVM=AMAX1(YMAXA,YMINA)                                        MCARLO   804
  106 XCIR=ABS(XBAR) + AMAX1(CEP,RCONF)                               MCARLO   805
      YCIR=ABS(YBAR)  + AMAX1(CEP,RCONF)                              MCARLO   806
  110 TSPRD=AMAX1(XDEVM,YDEVM,XCIR,YCIR)                              MCARLO   807
      IF(PSIZE.GT.0.) TSPRD=PSIZE/2.                                  MCARLO   808
      SCAL=TSPRD/21.                                                  MCARLO   809
      SCAL2=SCAL/2.                                                   MCARLO   810
      HSPRD=TSPRD                                                     MCARLO   811
      HSCAL=HSPRD/35.                                                 MCARLO   812
      CCIRTP=YBAR + CEP                                               MCARLO   813
      CCIRBT=YBAR - CEP                                               MCARLO   814
      RCIRTP=YBAR + RCONF                                             MCARLO   815
      RCIRBT=YBAR - RCONF                                             MCARLO   816
      IF(RCONF.LT.CEP)RCIRTP=-100000.                                 MCARLO   817
      YCEP = CCIRTP + SCAL                                            MCARLO   818
      YRCNF = RCIRTP + SCAL                                           MCARLO   819
      ICSW = 0                                                        MCARLO   820
      TU = TSPRD + SCAL                                               MCARLO   821
      NJ=1                                                            MCARLO   822
      CALL XLOC(0.,HSPRD,IWD,INDX)                                    MCARLO   823
      IXWD=IWD                                                        MCARLO   824
      IXNDX = INDX                                                    MCARLO   825
      DO 15 I=1,44                                                    MCARLO   826
      TU=TU - SCAL                                                    MCARLO   827
      PLINE(IXWD)= RCR.A.MSKK(IXNDX).O.PLINE(IXWD).A..N.MSKK(IXNDX)   MCARLO   828
      IF(0..LT.TU.OR.ITGTSW.GT.0) GO TO 2222                          MCARLO   829
      DO 2223 IOP=7,16                                                MCARLO   830
 2223 PLINE(IOP)=RCR                                                  MCARLO   831
 2222 CONTINUE                                                        MCARLO   832
      IF(CCIRTP.LT.TU.OR.TU.LT.CCIRBT) GO TO 5180                     MCARLO   833
      YCEP=YCEP - SCAL                                                MCARLO   834
      ARGG=CEP**2 - YCEP**2 + 2*YCEP*YBAR - YBAR**2                   MCARLO   835
      IF(ARGG.LT.0) GO TO 5180                                        MCARLO   836
      RAD=SQRT(ARGG)                                                  MCARLO   837
      GO TO 5181                                                      MCARLO   838
 5180 CONTINUE                                                        MCARLO   839
      IF(CCIRTP.LT.TU) GO TO 205                                      MCARLO   840
      IF(ABS(TU - CCIRBT).GT.SCAL2) GO TO 205                         MCARLO   841
      RAD=0.                                                          MCARLO   842
 5181 CONTINUE                                                        MCARLO   843
      XXL=XBAR - RAD                                                  MCARLO   844
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```
      CALL XLOC(XXL,HSPRD,IWD,INDX)                                  MCARLO   845
      PLINE(IWD)=CPR.A.MSKK(INDX).O.PLINE(IWD).A..N.MSKK(INDX)       MCARLO   846
      XXU=XBAR + RAD                                                 MCARLO   847
      CALL XLOC(XXU,HSPRD,IWD,INDX)                                  MCARLO   848
      PLINE(IWD)=CPR.A.MSKK(INDX).O.PLINE(IWD).A..N.MSKK(INDX)       MCARLO   849
  205 IF(RCIRTP.LT.TU.OR.TU.LT.RCIRBT) GO TO 5190                    MCARLO   850
      YRCNF=YRCNF - SCAL                                             MCARLO   851
      ARRCNF=RCONF**2 - YRCNF**2 + 2*YRCNF*YBAR - YBAR**2            MCARLO   852
      IF(ARRCNF.LT.0) GO TO 5190                                     MCARLO   853
      RAD=SQRT(ARRCNF)                                               MCARLO   854
      GO TO 5191                                                     MCARLO   855
 5190 CONTINUE                                                       MCARLO   856
      IF(RCIRTP.LT.TU) GO TO 207                                     MCARLO   857
      IF(ABS(TU - RCIRBT).GT.SCAL2) GO TO 207                        MCARLO   858
      RAD=0.                                                         MCARLO   859
 5191 CONTINUE                                                       MCARLO   860
      XXL=XBAR - RAD                                                 MCARLO   861
      CALL XLOC(XXL,HSPRD,IWD,INDX)                                  MCARLO   862
      PLINE(IWD)=RCR.A.MSKK(INDX).O.PLINE(IWD).A..N.MSKK(INDX)       MCARLO   863
      XXU=XBAR + RAD                                                 MCARLO   864
      CALL XLOC(XXU,HSPRD,IWD,INDX)                                  MCARLO   865
      PLINE(IWD)=RCR.A.MSKK(INDX).O.PLINE(IWD).A..N.MSKK(INDX)       MCARLO   866
  207 IF(ICSW.GT.0) GO TO 210                                        MCARLO   867
      IF(YBAR.LT.TU) GO TO 210                                       MCARLO   868
      ICSW=1                                                         MCARLO   869
      CALL XLOC(XBAR,HSPRD,IWD,INDX)                                 MCARLO   870
      PLINE(IWD)=CPCEN.A.MSKK(INDX).O.PLINE(IWD).A..N.MSKK(INDX)     MCARLO   871
  210 IF(0..LT.TU.OR.ITGTSW.GT.0) GO TO 213                          MCARLO   872
      ITGTSW=1                                                       MCARLO   873
      CALL XLOC(0.,HSPRD,IWD,INDX)                                   MCARLO   874
      PLINE(IWD)=TGT.A.MSKK(INDX).O.PLINE(IWD).A..N.MSKK(INDX)       MCARLO   875
  213 JQ=0                                                           MCARLO   876
      IF(NJ.GT.NP) GO TO 202                                         MCARLO   877
      DO 16 K=NJ,NP                                                  MCARLO   878
      IF(SORTY(K).LT.TU) GO TO 201                                   MCARLO   879
      JQ=JQ+1                                                        MCARLO   880
      CALL XLOC(SORTX(K),HSPRD,IWD,INDX)                             MCARLO   881
      PLINE(IWD)=PP.A.MSKK(INDX).O.PLINE(IWD).A..N.MSKK(INDX)        MCARLO   882
   16 CONTINUE                                                       MCARLO   883
  201 NJ=NJ+JQ                                                       MCARLO   884
  202 WRITE(6,1022)(PLINE(KUG),KUG=3,19)                             MCARLO   885
 1022 FORMAT(1X,16A7,A5)                                             MCARLO   886
      DO 33 KUG=1,19                                                 MCARLO   887
   33 PLINE(KUG)=BLNKK                                               MCARLO   888
   15 CONTINUE                                                       MCARLO   889
      WRITE(6,1003)                                                  MCARLO   890
      DX=SQRT(XBAR**2+YBAR**2)                                       MCARLO   891
      WRITE(6,1021)XBAR,YBAR,DX,CEP                                  MCARLO   892
 1021 FORMAT(1X,14HCEP CENTROID=(,F6.3,1H,,F6.3,1H),10X,22HDIST. FROM TG MCARLO   893
     *T CENTER=,F6.3,10X,4HCEP=,F5.3)                                MCARLO   894
      WRITE(6,1175)ICHI,RCONF                                        MCARLO   895
 1175 FORMAT(1X,4HTHE ,I4,1X,37HPER CENT CONFIDENCE CIRCLE RADIUS IS ,F6 MCARLO   896
     *.3)                                                            MCARLO   897
      RETURN                                                         MCARLO   898
      END                                                            MCARLO   899
```

```
      SUBROUTINE PPLOT      74/74   OPT=1                         FTN 4.2+74355       07/07/75  11.05.34.      PAGE     4

      SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS      DEF LINE      REFERENCES
     3 PPLOT          1          158

 VARIABLES       SN  TYPE              RELOCATION
   722 ARGG          REAL                          REFS        106       107    DEFINED      105
   726 ARRCNF        REAL                          REFS        123       124    DEFINED      122
   477 BLNKK         REAL                          REFS         31        34        150    DEFINED       15
   707 CCIRBT        REAL                          REFS        103       111    DEFINED       84
   706 CCIRTP        REAL                          REFS         88       103        110    DEFINED       83
     0 CEP           REAL              F.P.        REFS         22        75         76         83       84        87       105
                                                    162    DEFINED         1
   467 CEPX          REAL                          REFS         30    DEFINED          6
   470 CONFC         REAL                          REFS         41    DEFINED          7
   662 CPCCC         REAL                          REFS         32        35    DEFINED         31       34
   476 CPCEN         REAL                          REFS         31       141    DEFINED         14
   473 CPR           REAL                          REFS        116       113    DEFINED         11
   732 DX            REAL                          REFS        162    DEFINED        161
   471 EPSLN       * REAL                       DEFINED          8
   705 HSCAL       * REAL                       DEFINED         82
   704 HSPRD         REAL                          REFS         82        93        115        118      132       135       140
                                                    144        151    DEFINED         81
   661 I             INTEGER                       REFS         26        52         53         54     2*56      2*57
                                                DEFINED         26        43         51         96
     0 ICHI          INTEGER           F.P.        REFS         40        41        165    DEFINED        1
   655 ICIRSW      * INTEGER                    DEFINED         20
   712 ICSW          INTEGER                       REFS        137    DEFINED         90        139
   716 INDX          INTEGER                       REFS         93        95        115      2*116      118     2*119       132
                                                  2*133        135     2*136        140      2*141      144     2*145       151
                                                  2*152
   721 IOP           INTEGER                       REFS        101    DEFINED        100
   656 ITGTSW        INTEGER                       REFS         99       142    DEFINED         21      143
   715 IWD           INTEGER                       REFS         93        94        115      2*116      118     2*119       132
                                                  2*133        135     2*136        140      2*141      144     2*145       151
                                                  2*152
   720 IXNDX         INTEGER                       REFS       2*93    DEFINED         95
   717 IXWD          INTEGER                       REFS       2*98    DEFINED         94
   670 IY            INTEGER                       REFS         60        61         62         63   DEFINED       54
   727 JQ            INTEGER                       REFS        150       154    DEFINED        146      150
   730 K             INTEGER                       REFS        149       151    DEFINED        148
   731 KUS           INTEGER                       REFS        155       159    DEFINED        155      157
  1271 MSKK          INTEGER   ARRAY               REFS          4      2*31       2*34       2*98    2*116     2*119      2*133
                                                  2*136      2*141     2*145      2*152    DEFINED       15
   663 ND            INTEGER                       REFS         51        55         61         63       64        65
                                                DEFINED         46        64
   714 NJ            INTEGER                       REFS        147       148        154    DEFINED       92       154
     0 NP            INTEGER           F.P.        REFS         46        55         73        147      148
                                                DEFINED          1
   664 NS            INTEGER                       REFS         59        60         62         66       67        68
                                                DEFINED         47        59         66
  1243 PLINE         REAL      ARRAY               REFS          3        93        116        119      133       136       141
                                                    145        152       155    DEFINED          9       98       101       116
                                                    119        133       135        141        145      152       158
   466 POINTS        REAL                          REFS         29    DEFINED          5
   472 PP            REAL                          REFS        152    DEFINED         10
     0 PSIZE         REAL              F.P.        REFS       2*78    DEFINED          1
```

```
        SUBROUTINE PPLOT        74/74   OPT=1                          FTN 4.2+74355     07/07/75  11.05.34.     PAGE    5
VARIABLES         SN  TYPE              RELOCATION
   723  RAD           REAL                            REFS       114      112      131      134   DEFINED     107      112
                                                       124       129
   711  RCIRBT        REAL                            REFS       120      123   DEFINED      86
   710  RCIRTP        REAL                            REFS        89      120      127   DEFINED      85      87
     0  RCONF         REAL                F.P.        REFS        23       75       76      85       86      87      122
                                                       165   DEFINED        1
   474  RCR           REAL                            REFS        98      101      133      136   DEFINED      12
   702  SCAL          REAL                            REFS        80       83       89       91       97     104      121
                                                   DEFINED        79
   703  SCAL2         REAL                            REFS       111      123   DEFINED      88
  1077  SORTX         REAL     ARRAY                  REFS         3      151   DEFINED      62       68
   733  SORTY         REAL     ARRAY                  REFS         3       72       73      149   DEFINED      60      67
   475  TGT           REAL                            REFS        34      145   DEFINED      13
     0  TITLE         REAL     ARRAY      F.P.        REFS         3       25   DEFINED       1
   701  TSPRD         REAL                            REFS        79       81       91   DEFINED      77      78
   713  TU            REAL                            REFS        97       93    2*103      110      111   2*120     127
                                                       128       138      142      149   DEFINED      91      97
     0  X             REAL     ARRAY      F.P.        REFS         3     2*56     2*57       62       63      68
                                                   DEFINED         1       63
     0  XBAR          REAL                F.P.        REFS        75      114      117      131      134     140     161
                                                       162   DEFINED        1
   677  XCIR          REAL                            REFS        77   DEFINED      75
   673  XDEVM         REAL                            REFS        77   DEFINED      71
     0  XLAMBD        REAL                F.P.        REFS        26   DEFINED       1
   666  XMAX          REAL                            REFS        56       63   DEFINED      49       56
   671  XMAXA         REAL                            REFS        71   DEFINED      69
   665  XMIN          REAL                            REFS        57       70   DEFINED      48       57
   672  XMINA         REAL                            REFS        71   DEFINED      70
   724  XXL           REAL                            REFS       115      132   DEFINED     114      131
   725  XXU           REAL                            REFS       118      135   DEFINED     117      134
     0  Y             REAL     ARRAY      F.P.        REFS         3       52       53       60       61      67
                                                   DEFINED         1       61
     0  YBAR          REAL                F.P.        REFS        76       83       84       85       86   2*105   2*122
                                                       138       161      162   DEFINED       1
   657  YCEP          REAL                            REFS       104    2*105   DEFINED      22       88     104
   700  YCIR          REAL                            REFS        77   DEFINED      76
   676  YDEVM         REAL                            REFS        77   DEFINED      74
   667  YMAX          REAL                            REFS        52   DEFINED      50       53
   674  YMAXA         REAL                            REFS        74   DEFINED      72
   675  YMINA         REAL                            REFS        74   DEFINED      73
   660  YRINF         REAL                            REFS       121    2*122   DEFINED      23       89     121
FILE NAMES            MODE
        TAPE6         FMT                           WRITES        24       26       28       29       30      32      35      41
                                                        44       155      160      162      165
EXTERNALS             TYPE     ARGS      REFERENCES
        SQRT          REAL       1 LIBRARY   107       124      161
        XLOG                     4            93       115      118      132      135      140     144     151
INLINE FUNCTIONS      TYPE     ARGS      DEF LINE  REFERENCES
        ABS           REAL       1  INTRIN              69       70       72       73       75      76     111     128
        AMAX1         REAL       0  INTRIN              71       74       75       76       77
STATEMENT LABELS                      DEF LINE   REFERENCES
     0  1                                 44        43
   102  2                                 58        51       55
```

```
STATEMENT LABELS                DEF LINE    REFERENCES
    0  15                          159         96
    0  16                          153        148
    0  33                          158        157
   41  100                          42         40
   74  101                          55         52
   56  103                          50         65
    0  105           INACTIVE       75
    0  110           INACTIVE       77
  416  201                         154        149
  420  202                         155        147
  300  205                         120        110        111
  345  207                         137        127        128
  361  210                         142        137        138
  373  213                         146        142
  503  1000     FMT                 25         24
  512  1001     FMT                 27         26
  547  1002     FMT                 37         29
  552  1003     FMT                 38         28         44         160
  617  1021     FMT                163        162
  602  1022     FMT                156        155
  554  1072     FMT                 39         30
  570  1073     FMT                 45         41
  636  1175     FMT                166        165
  534  1492     FMT                 33         32
  544  1493     FMT                 36         35
  233  2222                        102         99
    0  2223                        101        100
  251  5190                        109        103        106
  260  5191                        113        108
  316  5130                        126        120        123
  325  5131                        130        125

LOOPS  LABEL    INDEX     FROM-TO    LENGTH     PROPERTIES
   42  1      * I          43 44        58                EXT REFS
   70  2      * I          51 58       158          OPT
  217  15     * I          96 159     2113                EXT REFS  NOT INNER
  231  2223     IOP       100 101       28      INSTACK
  400  16     * K         148 153      168                EXT REFS     EXITS
  424  33       KUG       157 158       28      INSTACK

STATISTICS
  PROGRAM LENGTH             1315B     717
```

```
      SUBROUTINE XLOC(XVAL,HSPRD,IND,INDX)                  MCARLO  900
      XD=ABS(-HSPRD - XVAL)                                 MCARLO  901
      XR=XD/(2.*HSPRD)                                      MCARLO  902
      RK=XR*70.                                             MCARLO  903
      KK=RK                                                 MCARLO  904
      RKK=KK                                                MCARLO  905
      RMDR=RK-RKK                                           MCARLO  906
      IF(RMDR.GE.0.5) KK=KK+1                               MCARLO  907
      KK1=KK - 1                                            MCARLO  908
      IND=KK1/7                                             MCARLO  909
      INDX=KK - 7*IND                                       MCARLO  910
      IND=IND + 7                                           MCARLO  911
      RETURN                                                MCARLO  912
      END                                                   MCARLO  913
```

```
      SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE      REFERENCES
   3 XLOC                1        13

VARIABLES        SN  TYPE              RELOCATION
    0  MSPRD        REAL                   F.P.         REFS        2        3    DEFINED      1
    0  INDX         INTEGER                F.P.      DEFINED        1       11
    0  IND          INTEGER                F.P.         REFS       11       12    DEFINED      1       10       12
   37  KK           INTEGER                             REFS        6        8          9     11   DEFINED      5      8
   42  KK1          INTEGER                             REFS       10   DEFINED         9
   36  RK           REAL                                REFS        5        7    DEFINED      4
   40  RKK          REAL                                REFS        7   DEFINED         6
   41  RMDR         REAL                                REFS        8   DEFINED         7
   34  XD           REAL                                REFS        3   DEFINED         2
   35  XR           REAL                                REFS        4   DEFINED         3
    0  XVAL         REAL                   F.P.         REFS        2   DEFINED         1

INLINE FUNCTIONS     TYPE    ARGS        DEF LINE   REFERENCES
      ABS            REAL       1  INTRIN               2

STATISTICS
  PROGRAM LENGTH                438     35
```

```
SUBROUTINE G2          74/74    OPT=1                                    FTN 4.2+74355        07/07/75  11.05.41.        PAGE     1

      SUBROUTINE G2                                                      G2        2
C ** MONTE CARLO WINDS **                                                G2        3
      COMMON /C/ C(3830)                                                 LABC04    4
      EQUIVALENCE (C(3753), ITNDX)                                       G2        5
      EQUIVALENCE (C(3721),ITCT)                                         G2        6
      EQUIVALENCE (C(  52),   VWTE)                                      G2        7
      EQUIVALENCE (C(  54),   SIGU)                                      G2        8
      EQUIVALENCE (C(  56),    BLU)                                      G2        9
      EQUIVALENCE (C(  58),  WNDW0)                                      G2       10
      EQUIVALENCE (C(  59),   SLW0)                                      G2       11
      EQUIVALENCE (C(  60),    RLW)                                      G2       12
      EQUIVALENCE (C(  62),    SLW)                                      G2       13
      EQUIVALENCE (C(  65),CBPSIW)                                       G2       14
      EQUIVALENCE (C(  66),SBPSIW)                                       G2       15
      EQUIVALENCE (C(  69), GSIGU)                                       G2       16
      EQUIVALENCE (C(  70), GVWTE)                                       G2       17
      EQUIVALENCE (C( 100),   VWXE)                                      G2       18
      EQUIVALENCE (C( 101),  VWYE)                                       G2       19
      EQUIVALENCE (C( 102),  VWZE)                                       G2       20
      EQUIVALENCE (C(1503),    VXE)                                      G2       21
      EQUIVALENCE (C(1507),    VYE)                                      G2       22
      EQUIVALENCE (C(1511),    VZE)                                      G2       23
      DIMENSION ITNDX(10)                                                G2       24
      DATA RNSTRT /0./                                                   G2       25
      ICK = 0                                                            G2       26
      DO 500 IOL = 1,ITCT                                                G2       27
      ITSNDX = IOL                                                       G2       28
C                                                                        G2       29
C  MONTE CARLO WIND GUSTS TIME SERIES                                    G2       30
      IF(ITNDX(IOL).NE.70) GO TO 502                                     G2       31
      UBAR = 0.                                                          G2       32
      IF(VWTE.NE.0.) UBAR = ABS((VXE*VWXE + VYE*VWYE + VZE*VWZE)/VWTE)   G2       33
      CALL MCARLO(DUM, 2, ITSNDX)                                        G2       34
      WNDW02 = UBAR/BLU + WNDW0                                          G2       35
      GLW = GSIGU*SQRT(WNDW02)                                           G2       36
      SLW0 = RLW - WNDW02*SLW                                            G2       37
      GVWTE = VWTE + GLW*SLW                                             G2       38
      ICK = 1                                                            G2       39
  502 CONTINUE                                                           G2       40
  500 CONTINUE                                                           G2       41
      IF(ICK.EQ.0) GO TO 503                                             G2       42
      VWXE = - GVWTE*CBPSIW                                              G2       43
      VWYE = - GVWTE*SBPSIW                                              G2       44
  503 CONTINUE                                                           G2       45
C                                                                        G2       46
      RETURN                                                             G2       47
      END                                                                G2       48
```

```
     SUBROUTINE G2          74/74   OPT=1                            FTN 4.2+74355      07/07/76  11.05.41.       PAGE     2

     SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS      DEF LINE      REFERENCES
    1  G2               1           46

 VARIABLES      SN  TYPE               RELOCATION
    87  BLJ          REAL                   C          REFS        8        34
     0  C            REAL          ARRAY    C          REFS        3         4         5         6         7         8         9
                                                            10       11        12        13        14        15        16        17
                                                            18       19        20        21        22
   100  CBPSIN       REAL                   C          REFS       13        42
    60  DUM       *  REAL                              REFS       33
    62  GLM          REAL                              REFS       37   DEFINED        35
   104  GSIGU        REAL                   C          REFS       15        35
   105  GVMTE        REAL                   C          REFS       16        42        43   DEFINED        87
    54  ICK          INTEGER                           REFS       41   DEFINED        25        38
    55  IOL          INTEGER                           REFS       27        30   DEFINED        26
  7210  ITST         INTEGER                C          REFS        5        25
  7250  ITNDX        INTEGER       ARRAY    C          REFS        4        23        30
    56  ITSNDX       INTEGER                           REFS       33   DEFINED        27
    73  RLM          REAL                   C          REFS       11        35
    52  RNSTRT    *  REAL                           DEFINED       24
   101  SBPSIN       REAL                   C          REFS       14        43
    65  SIGU         REAL                   C          REFS        7
    75  SLM          REAL                   C          REFS       12        35        37
    72  SLMD         REAL                   C          REFS       10   DEFINED        36
    57  UBAR         REAL                              REFS       34   DEFINED        31        32
    63  VMTE         REAL                   C          REFS        6      2*32        37
   143  VMXE         REAL                   C          REFS       17        32   DEFINED        42
   144  VMYE         REAL                   C          REFS       18        32   DEFINED        43
   145  VMZE         REAL                   C          REFS       19        32
  3102  VXE          REAL                   C          REFS       20        32
  3106  VYE          REAL                   C          REFS       21        32
  3112  VZE          REAL                   C          REFS       22        32
    71  WNDWD        REAL                   C          REFS        9        34
    61  WNDWD2       REAL                              REFS       35        36   DEFINED        34

 EXTERNALS          TYPE   ARGS        REFERENCES
        MCARLO               3               33
        SQRT        REAL     1 LIBRARY       35

 INLINE FUNCTIONS    TYPE   ARGS        DEF LINE   REFERENCES
        ABS          REAL     1  INTRIN                 32

 STATEMENT LABELS              DEF LINE     REFERENCES
     0  500                       40           26
    36  502                       39           30
    45  503                       44           41

 LOOPS  LABEL     INDEX       FROM-TO      LENGTH     PROPERTIES
    4   500     * IOL         26  40        35B                  EXT REFS

 COMMON BLOCKS   LENGTH       MEMBERS - BIAS NAME(LENGTH)
        C          3830              0 C       (3830)
```

```
     SUBROUTINE G2          74/74    OPT=1                              FTN 4.2+74355        07/07/75  11.05.41.        PAGE      3

 EQUIV CLASSES     LENGTH      MEMBERS - BIAS NAME(LENGTH)
C        C          3830                51 VWTE    (1)                      53 SISU    (1)                     55 SLU     (1)
                                        57 WNDWD   (1)                      58 SLWD    (1)                     59 RLW     (1)
                                        61 SLW     (1)                      64 CBPSIW  (1)                     65 SBPSIW  (1)
                                        68 GSIGU   (1)                      69 GVWTE   (1)                     99 VWXE    (1)
                                       100 VWYE    (1)                     101 VWZE    (1)                   1502 VXE     (1)
                                      1606 VYE     (1)                    1610 VZE     (1)                   3720 ITCT    (1)
                                      3752 ITNDX   (10)

 STATISTICS
   PROGRAM LENGTH                  638       51.
   CM LABELED COMMON LENGTH      73669     3830
```

```
      SUBROUTINE G21                                          G2      49
C**WIND AND GUSTS MODULE                                      G2      50
      COMMON /C/ C(3830)                                      LABC04   5
C**INPUT DATA                                                 G2      52
      EQUIVALENCE(C(2000),T)                                  G2      53
      EQUIVALENCE (C(  50),OPTNW )                            G2      54
      EQUIVALENCE (C(  51),BPSIW )                            G2      55
      EQUIVALENCE (C(  52),VWTE  )                            G2      56
C**OUTPUT DATA                                                G2      57
      EQUIVALENCE (C( 100),VWXE  )                            G2      58
      EQUIVALENCE (C( 101),VWYE  )                            G2      59
      EQUIVALENCE (C( 102),VWZE  )                            G2      60
C**INPUTS FROM OTHER MODULES                                  G2      61
      EQUIVALENCE (C(  54),  SIGU)                            G2      62
      EQUIVALENCE (C(  56),   BLU)                            G2      63
      EQUIVALENCE (C(  58), WNDWO)                            G2      64
      EQUIVALENCE (C(  59),  SLWO)                            G2      65
      EQUIVALENCE (C(  60),   RLW)                            G2      66
      EQUIVALENCE (C(  62),   SLW)                            G2      67
      EQUIVALENCE (C(  65),CBPSIW)                            G2      68
      EQUIVALENCE (C(  66),SBPSIW)                            G2      69
      EQUIVALENCE (C(  68), VWTEM)                            G2      70
      EQUIVALENCE (C(  69), GSIGU)                            G2      71
      EQUIVALENCE (C(2561),     N)                            G2      72
      EQUIVALENCE (C(2562),   IPL)                            G2      73
      EQUIVALENCE (C(3634), ISNDX)                            G2      74
      EQUIVALENCE (C(3512), I3512)                            G2      75
      EQUIVALENCE (C(3753), ITNDX)                            G2      76
      EQUIVALENCE (C(3721),  ITCT)                            G2      77
      DIMENSION IPL(100), ISNDX(40), ITNDX(10)                G2      78
C                                                             G2      79
      VWTEM=VWTE                                              G2      80
C MONTE CARLO STEADY STATE WIND COMPONENT                     G2      81
      DO 500 I = 1, I3512                                     G2      82
      IDO = I                                                 G2      83
      IF(ISNDX(I).EQ.51) CALL MCARLO (DUM, 1, IDO)            G2      84
      IF(ISNDX(I).EQ.52) CALL MCARLO (DUM, 1, IDO)            G2      85
  500 CONTINUE                                                G2      86
C                                                             G2      87
      VWTE = ABS(VWTE)                                        G2      88
      SLW = 0.                                                G2      89
C                                                             G2      90
C MONTE CARLO  INITIAL VALUE OF TIME SERIES WIND GUSTS        G2      91
      DO 501 I = 1,ITCT                                       G2      92
      IDO = I                                                 G2      93
      IF(ITNDX(I).NE.70) GO TO 501                            G2      94
      CALL MCARLO ( DUM,4,IDO)                                G2      95
      WNDWO = 1.                                              G2      96
      IF(VWTE.EQ.0.) GO TO 505                                G2      97
      SIGU = VWTE/2.9                                         G2      98
      GO TO 506                                               G2      99
  505 CONTINUE                                                G2     100
      VWTE = 2.9 * SIGU                                       G2     101
  506 CONTINUE                                                G2     102
      GSIGU = SIGU*SQRT(1.09/C(2664))                         G2     103
      BLU = -12.1*SIGU + 475.                                 G2     104
      IF(VWTEM/VWTE.GT..1) WNDWO = VWTE/VWTEM                 G2     105
```

```
      IPL(N) = 59
      N = N + 1
  501 CONTINUE
C
      CBPSIW = COSD(BPSIW)
      SBPSIW = SIND(BPSIW)
      VWXE = - VWTE*CBPSIW
      VWYE = - VWTE*SBPSIW
      VWZE = 0.
      RETURN
      END
```

```
CARD NR. SEVERITY  DETAILS   DIAGNOSIS OF PROBLEM

   58       I       ITCT     THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.
```

```
SUBROUTINE G2I        74/74   OPT=1                            FTN 4.2+74355      07/07/76  11.05.42.     PAGE    4

      SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS     DEF LINE     REFERENCES
    1  G2I              1         67

VARIABLES      SN  TYPE              RELOCATION
   67  BLJ         REAL                   C          REFS      15   DEFINED     56
   62  BPSIW       REAL                   C          REFS       7      62       63
    0  C           REAL         ARRAY     C          REFS       3       5        6        7        8       10       11
                                                       12      14      15       16       17       18       19       20
                                                       21      22      23       24       25       26       27       28
                                                       29      55
  100  CB*SIW      REAL                   C          REFS      20      64    DEFINED     62
  115  DUM         REAL                              REFS      36      37       47
  104  GSIGU       REAL                   C          REFS      23   DEFINED     55
  113  I           INTEGER                           REFS      35      35       37       45       46
                                                  DEFINED      34      44
  114  IDO         INTEGER                           REFS      36      37       47    DEFINED     35       45
 3001  IPL         INTEGER      ARRAY     C          REFS      25      30    DEFINED     58
 7061  ISNDX       INTEGER      ARRAY     C          REFS      26      30       36       37
 7210  ITCT        INTEGER                C          REFS      29      44
 7250  ITNDX       INTEGER      ARRAY     C          REFS      28      30       46
 5667  I3512       INTEGER                C          REFS      27      34
 5000  N           INTEGER                C          REFS      24      58       59    DEFINED     59
   61  OPTNW       REAL                   C          REFS       6
   73  RLW         REAL                   C          REFS      18
  101  SBPSIW      REAL                   C          REFS      21      65    DEFINED     63
   65  SIGU        REAL                   C          REFS      14      53       55       56    DEFINED     50
   75  SLW         REAL                   C          REFS      19   DEFINED     41
   72  SLWD        REAL                   C          REFS      17
 3717  T           REAL                   C          REFS       5
   63  VWTE        REAL                   C          REFS       8      32       40       49       50     2*57       64
                                                       65   DEFINED    40       53
  103  VWTEM       REAL                   C          REFS      22    2*57    DEFINED     32
  143  VWXE        REAL                   C          REFS      10   DEFINED     64
  144  VWYE        REAL                   C          REFS      11   DEFINED     65
  145  VWZE        REAL                   C          REFS      12   DEFINED     66
   71  WNDWU       REAL                   C          REFS      16   DEFINED     48       57

EXTERNALS          TYPE   ARGS       REFERENCES
       COSD        REAL     1            62
       MCARLO               3            36        37       47
       SIND        REAL     1            63
       SQRT        REAL     1 LIBRARY    55

INLINE FUNCTIONS   TYPE   ARGS       DEF LINE   REFERENCES
       ABS         REAL     1  INTRIN                40

STATEMENT LABELS              DEF LINE   REFERENCES
    0  500                       38         34
   55  501                       60         44        46
   36  503                       52         49
   40  505                       54         51

LOOPS  LABEL    INDEX     FROM-TO    LENGTH     PROPERTIES
    5  500       * I       34 38      143             EXT REFS
   24  501       * I       44 60      343             EXT REFS
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      SUBROUTINE G2I          74/74    OPT=1                          FTN 4.2+74355        07/07/75  11.05.42.        PAGE      5

    COMMON BLOCKS     LENGTH        MEMBERS - BIAS NAME(LENGTH)
            C           3830                     0 C        (3830)

    EQUIV CLASSES     LENGTH        MEMBERS - BIAS NAME(LENGTH)
  C         C           3830                    49 OPTNW    (1)                  50 BPSIW    (1)                  51 VWTE     (1)
                                                53 SIGU     (1)                  55 BLJ      (1)                  57 WNDW0    (1)
                                                58 SLWD     (1)                  59 RLW      (1)                  61 SLW      (1)
                                                64 CSPSIW   (1)                  65 SBPSIW   (1)                  67 VWTEW    (1)
                                                68 GSIGU    (1)                  99 VWXE     (1)                 100 VWYE     (1)
                                               101 VWZE     (1)                1999 T        (1)                2550 N        (1)
                                              2561 IPL      (100)              3511 I3512    (1)                3633 ISNDX    (40)
                                              3720 ITCT     (1)                3752 ITNDX    (10)

    STATISTICS
      PROGRAM LENGTH                    1168       73
      CM LABELED COMMON LENGTH         73663     3830
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```
      SUBROUTINE G3                                                 G3         2
C**AIR DATA MODULE G3                                               G3         3
      COMMON /C/ C(3838)                                            LABCOM     4
C**INPUT DATA                                                       G3         5
      EQUIVALENCE (C(0208),RHZRO )                                  G3         6
C**INPUTS FROM OTHER MODULES                                        G3         7
      EQUIVALENCE (C(0100),VWXE  )                                  G3         8
      EQUIVALENCE (C(0101),VWYE  )                                  G3         9
      EQUIVALENCE (C(0102),VWZE  )                                  G3        10
      EQUIVALENCE (C(1603),VXE   )                                  G3        11
      EQUIVALENCE (C(1607),VYE   )                                  G3        12
      EQUIVALENCE (C(1611),VZE   )                                  G3        13
      EQUIVALENCE (C(1623),RZE   )                                  G3        14
C**INPUTS FROM MAIN PROGRAM                                         G3        15
C**STATE VARIABLE OUTPUTS                                           G3        16
C**NONE                                                             G3        17
C**OTHER OUTPUTS                                                    G3        18
      EQUIVALENCE (C(0200),VMWXE )                                  G3        19
      EQUIVALENCE (C(0201),VMWYE )                                  G3        20
      EQUIVALENCE (C(0202),VMWZE )                                  G3        21
      EQUIVALENCE (C(0203),PDYNMC)                                  G3        22
      EQUIVALENCE (C(0204),VMACH )                                  G3        23
      EQUIVALENCE (C(0205),DRHO  )                                  G3        24
      EQUIVALENCE (C(0206),VSOUND)                                  G3        25
      EQUIVALENCE (C(0207),VAIRSP)                                  G3        26
      EQUIVALENCE (C(0209),RH    )                                  G3        27
C**CALCULATE PRESENT ALTITUDE                                       G3        28
      RH= -RZE+RHZRO                                                G3        29
C**CALCULATE MISSILE VELOCITY WRT AIR MASS IN EARTH AXES            G3        30
      VMWXE = VXE-VWXE                                              G3        31
      VMWYE = VYE-VWYE                                              G3        32
      VMWZE = VZE-VWZE                                              G3        33
      VAIRSP = SQRT(VMWXE*VMWXE+VMWYE*VMWYE+VMWZE*VMWZE)            G3        34
C**AIR DENSITY, SPEED OF SOUND, DYNAMIC PRESSURE, AND MACH          G3        35
      DRHO=(.076475)/(1.+.3325E-04*RH+RH*RH*RH*.02315E-12)          G3        36
      VSOUND = -.00392*RH+1117.3                                    G3        37
      PDYNMC = (DRHO*VAIRSP*VAIRSP)/64.344                          G3        38
      VMACH = VAIRSP/VSOUND                                         G3        39
      RETURN                                                        G3        40
      END                                                           G3        41
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       SUBROUTINE G3          74/74    OPT=1                            FTN 4.2+74355      07/07/76  11.05.43.        PAGE     2

       SYMBOLIC REFERENCE MAP (R=3)

  ENTRY POINTS      DEF LINE      REFERENCES
     1  G3               1           39

  VARIABLES       SN  TYPE              RELOCATION
        D  C            REAL          ARRAY    C        REFS       3          5          7          8          9         10         11
                                                          12         13         13         19         20         21         22         23
                                                          24         25         25
    314  DRHO           REAL                  C        REFS       23         37    DEFINED         35
    312  PDYNMC         REAL                  C        REFS       21    DEFINED         37
    320  RH             REAL                  C        REFS       26       4*35         36    DEFINED         28
    317  RHZRO          REAL                  C        REFS        5         23
   3126  RZE            REAL                  C        REFS       13         28
    316  VAIRSP         REAL                  C        REFS       25       2*37         38    DEFINED         53
    313  VMACH          REAL                  C        REFS       22    DEFINED         38
    307  VMWXE          REAL                  C        REFS       18       2*33    DEFINED         30
    310  VMWYE          REAL                  C        REFS       19       2*33    DEFINED         31
    311  VMWZE          REAL                  C        REFS       20       2*33    DEFINED         32
    315  VSOUND         REAL                  C        REFS       24         35    DEFINED         36
    143  VWXE           REAL                  C        REFS        7         30
    144  VWYE           REAL                  C        REFS        8         31
    145  VWZE           REAL                  C        REFS        9         32
   3102  VXE            REAL                  C        REFS       10         30
   3106  VYE            REAL                  C        REFS       11         31
   3112  VZE            REAL                  C        REFS       12         32

  EXTERNALS              TYPE    ARGS           REFERENCES
        SQRT             REAL       1 LIBRARY       33

  COMMON BLOCKS     LENGTH       MEMBERS - BIAS NAME(LENGTH)
        C             3830               0 C        (3830)

  EQUIV CLASSES     LENGTH       MEMBERS - BIAS NAME(LENGTH)
  C     C             3830              99 VWXE     (1)             100 VWYE     (1)             101 VWZE     (1)
                                       199 VMWXE    (1)             200 VMWYE    (1)             201 VMWZE    (1)
                                       202 PDYNMC   (1)             203 VMACH    (1)             204 DRHO     (1)
                                       205 VSOUND   (1)             206 VAIRSP   (1)             207 RHZRO    (1)
                                       208 RH       (1)            1602 VXE      (1)            1605 VYE      (1)
                                      1610 VZE      (1)            1622 RZE      (1)

  STATISTICS
     PROGRAM LENGTH                   40B         32
     CM LABELED COMMON LENGTH       7366B       3830
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      SUBROUTINE G5                                                      G5         2
C**COORDINATE CONVERSION MODULE                                          G5         3
      COMMON /C/ C(3830)                                                 LABC04     4
C                                                                        G5         5
C**INPUTS FROM OTHER MODULES                                             G5         6
      EQUIVALENCE (C(0200),VMWXE )                                       G5         7
      EQUIVALENCE (C(0201),VMWYE )                                       G5         8
      EQUIVALENCE (C(0202),VMWZE )                                       G5         9
      EQUIVALENCE (C(0207),VAIRSP)                                       G5        10
      EQUIVALENCE (C(1317),RAIL  )                                       G5        11
      EQUIVALENCE (C(1405),QBURN )                                       G5        12
      EQUIVALENCE (C(1603),VXE   )                                       G5        13
      EQUIVALENCE (C(1607),VYE   )                                       G5        14
      EQUIVALENCE (C(1611),VZE   )                                       G5        15
      EQUIVALENCE (C(1615),RXE   )                                       G5        16
      EQUIVALENCE (C(1619),RYE   )                                       G5        17
      EQUIVALENCE (C(1623),RZE   )                                       G5        18
      EQUIVALENCE (C(1635),RDELX )                                       G5        19
      EQUIVALENCE (C(1636),RDELY )                                       G5        20
      EQUIVALENCE (C(1637),RDELZ )                                       G5        21
      EQUIVALENCE (C(1651),RTXE  )                                       G5        22
      EQUIVALENCE (C(1655),RTYE  )                                       G5        23
      EQUIVALENCE (C(1659),RTZE  )                                       G5        24
      EQUIVALENCE (C(1668),RXO   )                                       G5        25
      EQUIVALENCE (C(1669),RYO   )                                       G5        26
      EQUIVALENCE (C(1670),RZO   )                                       G5        27
      EQUIVALENCE (C(1671),VXO   )                                       G5        28
      EQUIVALENCE (C(1672),VYO   )                                       G5        29
      EQUIVALENCE (C(1673),VZO   )                                       G5        30
      EQUIVALENCE (C(1680),RSJYMC)                                       G5        31
      EQUIVALENCE (C(1681),RSJZMC)                                       G5        32
      EQUIVALENCE (C(1682),RSPOTX)                                       G5        33
      EQUIVALENCE (C(1683),RSPOTY)                                       G5        34
      EQUIVALENCE (C(1684),RSPOTZ)                                       G5        35
      EQUIVALENCE (C(3753), ITNDX)                                       G5        36
      EQUIVALENCE (C(3721),  ITCT)                                       G5        37
      EQUIVALENCE (C(1560), SXPDD)                                       G5        38
      EQUIVALENCE (C(1561),    RX)                                       G5        39
      EQUIVALENCE (C(1562),GSPOTY)                                       G5        40
      EQUIVALENCE (C(1563),  SXPD)                                       G5        41
      EQUIVALENCE (C(1566),   SXP)                                       G5        42
      EQUIVALENCE (C(1570), SYPDD)                                       G5        43
      EQUIVALENCE (C(1571),    RY)                                       G5        44
      EQUIVALENCE (C(1572),GSPOTZ)                                       G5        45
      EQUIVALENCE (C(1573),  SYPD)                                       G5        46
      EQUIVALENCE (C(1576),   SYP)                                       G5        47
      EQUIVALENCE (C(1579),  ZETA)                                       G5        48
      EQUIVALENCE (C(1580),    WO)                                       G5        49
      DIMENSION ITNDX(10)                                                G5        50
      EQUIVALENCE (C(1703),CFA11 )                                       G5        51
      EQUIVALENCE (C(1707),CFA12 )                                       G5        52
      EQUIVALENCE (C(1711),CFA13 )                                       G5        53
      EQUIVALENCE (C(1715),CFA21 )                                       G5        54
      EQUIVALENCE (C(1719),CFA22 )                                       G5        55
      EQUIVALENCE (C(1723),CFA23 )                                       G5        56
      EQUIVALENCE (C(1727),CFA31 )                                       G5        57
      EQUIVALENCE (C(1731),CFA32 )                                       G5        58
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      EQUIVALENCE (C(1735),CFA33 )                                        G5       59
      EQUIVALENCE (C(1751),CRAD  )                                        G5       60
      EQUIVALENCE (C(1768),  XB01)                                        G5       61
      EQUIVALENCE (C(1769),  YB01)                                        G5       62
      EQUIVALENCE (C(1770),  ZB01)                                        G5       63
      EQUIVALENCE (C(1771),  XB02)                                        G5       64
      EQUIVALENCE (C(1772),  YB02)                                        G5       65
      EQUIVALENCE (C(1773),  ZB02)                                        G5       66
      EQUIVALENCE (C(1764),    P1)                                        G5       67
      EQUIVALENCE (C(1765),R1)                                            ROLLGYRO  1
      EQUIVALENCE (C(1761),  A011)                                        G5       71
      EQUIVALENCE (C(1762),  A012)                                        G5       72
      EQUIVALENCE (C(1763),  A013)                                        G5       73
      EQUIVALENCE (C(1755),A021  )                                        G5       74
      EQUIVALENCE (C(1756),A022  )                                        G5       75
      EQUIVALENCE (C(1757),A023  )                                        G5       76
      EQUIVALENCE (C(1758),A031  )                                        G5       77
      EQUIVALENCE (C(1759),A032  )                                        G5       78
      EQUIVALENCE (C(1760),A033  )                                        G5       79
      EQUIVALENCE (C(2000),T     )                                        G5       80
C                                                                         G5       81
C**OTHER OUTPUTS                                                          G5       82
      EQUIVALENCE (C(0350),BTHT  )                                        G5       83
      EQUIVALENCE (C(0351),BPSI  )                                        G5       84
      EQUIVALENCE (C(0352),BPHI  )                                        G5       85
      EQUIVALENCE (C( 353),BPH1  )                                        G5       86
      EQUIVALENCE (C( 354),BTH2  )                                        G5       87
      EQUIVALENCE (C( 355),BPS1  )                                        G5       88
      EQUIVALENCE (C(0356),VTOTE )                                        G5       89
      EQUIVALENCE (C(0357),BGAMH )                                        G5       90
      EQUIVALENCE (C(0358),BGAMV )                                        G5       91
      EQUIVALENCE (C(0363),BTHLV )                                        G5       92
      EQUIVALENCE (C(0364),BPSLV )                                        G5       93
      EQUIVALENCE (C(0365),BLAMV )                                        G5       94
      EQUIVALENCE (C(0366),BLAMH )                                        G5       95
      EQUIVALENCE (C(0367),BALPHA)                                        G5       96
      EQUIVALENCE (C(0368),BALPHY)                                        G5       97
      EQUIVALENCE (C(0369),BALPHP)                                        G5       98
      EQUIVALENCE (C(0370),BPHIP )                                        G5       99
      EQUIVALENCE (C(0371),RANGE )                                        G5      100
      EQUIVALENCE (C(0372),RXBA  )                                        G5      101
      EQUIVALENCE (C(0373),RYBA  )                                        G5      102
      EQUIVALENCE (C(0374),RZBA  )                                        G5      103
      EQUIVALENCE (C( 380),RANGO )                                        G5      104
      EQUIVALENCE (C( 390),RXL   )                                        G5      105
      EQUIVALENCE (C( 391),RYL   )                                        G5      106
      EQUIVALENCE (C( 392),RZL   )                                        G5      107
      EQUIVALENCE (C( 393),BPH2  )                                        G5      108
C                                                                         G5      109
C**CALCULATION OF HEADING, PITCH, ROLL EULER ANGLES IN DEGREES            G5      110
      BPHI = ATAND(CFA23,CFA33)                                           G5      111
      BTHT = ATAND(-CFA13,SQRT(CFA11*CFA11+CFA12*CFA12))                  G5      112
      BPSI = ATAND(CFA12,CFA11)                                           G5      113
C                                                                         G5      114
C**FREE GYRO MODELS (INITIAL GIMBAL ANGLES ARE ZERO)                      G5      115
C                                                                         G5      116
C** AUTO PILOT DRIFT RATES                                                G5      117
```

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      C                                                                 ROLLGYRO   2
      C       ROLL GYRO DRIFT RATES P1, AND R1                          ROLLGYRO   3
            DXB01=R1*ZB01/CRAD                                          ROLLGYRO   4
            DYB01=-P1*ZB01/CRAD                                         ROLLGYRO   5
            DZB01=(P1*YB01-R1*XB01)/CRAD                                ROLLGYRO   6
      C                                                                 ROLLGYRO   7
      C                                                                 G5       124
            XB01 = DXB01*T                                              G5       125
            YB01 = 1. + DYB01*T                                         G5       126
            ZB01 = DZB01*T                                              G5       127
      C                                                                 ROLLGYRO   8
            B12 = A011*CFA21 + A012*CFA22 + A013*CFA23                  G5       132
            B13 = A011*CFA31 + A012*CFA32 + A013*CFA33                  G5       133
      C                                                                 ROLLGYRO   9
            B22 = A021*CFA21 + A022*CFA22 + A023*CFA23                  G5       135
            B23 = A021*CFA31 + A022*CFA32 + A023*CFA33                  G5       136
      C                                                                 ROLLGYRO  10
            B32 = A031*CFA21 + A032*CFA22 + A033*CFA23                  G5       138
            B33 = A031*CFA31 + A032*CFA32 + A033*CFA33                  G5       139
      C                                                                 ROLLGYRO  11
      C                                                                 ROLLGYRO  12
            YB1 = B12*XB01 + B22*YB01 + B32*ZB01                        G5       141
            ZB1 = B13*XB01 + B23*YB01 + B33*ZB01                        G5       142
      C                                                                 ROLLGYRO  13
            BPHI = ATAND (ZB1,YB1)                                      G5       146
      C                                                                 G5       150
      C**CALCULATION OF TOTAL VELOCITY                                  G5       151
            VTOTE = SQRT(VXE*VXE+VYE*VYE+VZE*VZE)                       G5       152
            RDELX = RTXE-RXE                                            G5       153
            RDELY = RTYE-RYE                                            G5       154
            RDELZ = RTZE-RZE                                            G5       155
      C                                                                 G5       156
            IF(C(1975).LE.0.) GO TO 20                                  G5       157
            RXL = RXE - RXO - VXO*T                                     G5       158
            RYL = RYE - RYO - VYO*T                                     G5       159
            RZL = RZE - RZO - VZO*T                                     G5       160
            RANGO = SQRT(RXL**2 + RYL**2 + RZL**2)                      G5       161
            VXL = VXE - VXO                                             G5       162
            VYL = VYE - VYO                                             G5       163
            VZL = VZE - VZO                                             G5       164
         20 CONTINUE                                                    G5       165
      C                                                                 G5       166
      C**TRANSFORM MISSILE LOS FROM EARTH TO BODY AXES                  G5       167
      C                                                                 G5       168
      C LINE OF SIGHT OF LASER SPOT WITH MONTE CARLO SPOT JITTER INCLUDED G5      169
      C                                                                 G5       170
            DO 500 I = 1, ITGT                                          G5       171
            IDO = I                                                     G5       172
            IF(ITNUX(I).NE.1600) GO TO 501                              G5       173
            RSJYMC = GSPOTY*SXP                                         G5       174
            CALL MCARLO (DUM,2,IDO)                                     G5       175
            SXPDC = WO*WO*(RX-2.*ZETA*SXPD/WO - SXP)                    G5       176
        501 IF(ITNUX(I).NE.1581) GO TO 500                              G5       177
            RSJZMC = GSPOTZ*SYP                                         G5       178
            CALL MCARLO (DUM,2,IDO)                                     G5       179
            SYPDC = WO*WO*(RY - 2.*ZETA*SYPD/WO - SYP)                  G5       180
        500 CONTINUE                                                    G5       181
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```
      RSPOTX = RDELX
      RSPOTY = RDELY + RSJYMC
      RSPOTZ = RDELZ + RSJZMC
      RXBA = RSPOTX*CFA11 + RSPOTY*CFA12 + RSPOTZ*CFA13
      RYBA = RSPOTX*CFA21 + RSPOTY*CFA22 + RSPOTZ*CFA23
      RZBA = RSPOTX*CFA31 + RSPOTY*CFA32 + RSPOTZ*CFA33
C
      UVP1 =  VXE*RDELX+VYE*RDELY
      UVP2 = RDELX*RDELX+RDELY*RDELY
      UVP3 = VZE*RDELZ
      UVP4 = SQRT(UVP2)
      RANGE = SQRT(UVP2+RDELZ**2)
C**VERTICAL AND HORIZONTAL LINE OF SIGHT ANGLES (EARTH AXES)
C
      BLAMH = ATAND(-RDELY,RDELX)
      BLAMV = ATAND(-RDELZ,UVP4)
C
C**VERTICAL AND HORIZONTAL PROPORTIONAL NAVIGATION ANGLES
      IF(VTOTE.LE.10.) GO TO 30
      VXP=(UVP1+UVP3)/RANGE
      VYP = ( VYE*RDELX-VXE*RDELY)/UVP4
      VZP = (VZE*UVP2-RDELZ*UVP1)/(RANGE*UVP4)
      BTHLV  = ATAND(VZP,VXP)
      BPSLV  = ATAND(VYP,VXP)
C
      BGAMV = ATAND(-VZE,SQRT(VXE*VXE+VYE*VYE))
      BGAMH = ATAND(VYE,VXE)
C
C**VELOCITY WRT AIR IN BODY AXES
      VMWU = CFA11*VMWXE+CFA12*VMWYE+CFA13*VMWZE
      VMWV = CFA21*VMWXE+CFA22*VMWYE+CFA23*VMWZE
      VMWW = CFA31*VMWXE+CFA32*VMWYE+CFA33*VMWZE
C
C**VERTICAL AND HORIZONTAL ANGLES OF ATTACK
      IF (QBURN.LE.0. .AND. RANGO.LE.RAILH) GO TO 30
      BALPHA = ATAND(VMWW,VMWU)
      BALPHY = ATAND(VMWV,VMWU)
C
C**ALPHA PRIME AND PHI PRIME (WIND TUNNEL AXES)
      IF ((BALPHA-BALPHY).EQ.0.) GO TO 30
      BPHIP = ATAND(BALPHY,BALPHA)
   30 BALPHP=SQRT(BALPHA**2+BALPHY**2)
      RETURN
      END
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      SUBROUTINE G5          74/74   OPT=1                        FTN 4.2+74355      07/07/75  11.05.44.      PAGE    5

      SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS     DEF LINE       REFERENCES
    1  G5             1           214

 VARIABLES      SN  TYPE            RELOCATION
  3340  A011         REAL                 C         REFS       68      125      127
  3341  A012         REAL                 C         REFS       69      125      127
  3342  A013         REAL                 C         REFS       70      125      127
  3332  A021         REAL                 C         REFS       71      129      130
  3333  A022         REAL                 C         REFS       72      129      130
  3334  A023         REAL                 C         REFS       73      129      130
  3335  A031         REAL                 C         REFS       74      132      133
  3336  A032         REAL                 C         REFS       75      132      133
  3337  A033         REAL                 C         REFS       76      132      133
   556  BALPHA       REAL                 C         REFS       93      211      212      213   DEFINED    207
   560  BALPHP       REAL                 C         REFS       95   DEFINED     213
   557  BALPHY       REAL                 C         REFS       94      211      212      213   DEFINED    208
   544  BGAMM        REAL                 C         REFS       87   DEFINED     198
   545  BGAMV        REAL                 C         REFS       88   DEFINED     197
   555  BLAMM        REAL                 C         REFS       92   DEFINED     186
   554  BLAMV        REAL                 C         REFS       91   DEFINED     187
   537  BPHI         REAL                 C         REFS       82   DEFINED     108
   561  BPHIP        REAL                 C         REFS       96   DEFINED     212
   540  BPH1         REAL                 C         REFS       83   DEFINED     139
   610  BPH2         REAL                 C         REFS      105
   536  BPSI         REAL                 C         REFS       81   DEFINED     110
   553  BPSLV        REAL                 C         REFS       90   DEFINED     195
   542  BPS1         REAL                 C         REFS       85
   552  BTHLV        REAL                 C         REFS       89   DEFINED     134
   535  BTHT         REAL                 C         REFS       80   DEFINED     109
   541  BTH2         REAL                 C         REFS       84
   426  B12          REAL                           REFS      136   DEFINED     126
   427  B13          REAL                           REFS      137   DEFINED     127
   430  B22          REAL                           REFS      136   DEFINED     129
   431  B23          REAL                           REFS      137   DEFINED     130
   432  B32          REAL                           REFS      136   DEFINED     132
   433  B33          REAL                           REFS      137   DEFINED     133
     0  C            REAL        ARRAY    C         REFS        3        5        7        8        9       10       11
                                                       12       13       14       15       16       17       18       19
                                                       20       21       22       23       24       25       26       27
                                                       28       29       30       31       32       33       34       35
                                                       36       37       38       39       40       41       42       43
                                                       44       45       46       47       48       50       51       52
                                                       53       54       55       56       57       58       59       60
                                                       61       62       63       64       65       66       67       68
                                                       69       70       71       72       73       74       75       76
                                                       77       80       81       82       83       84       85       86
                                                       87       88       89       90       91       92       93       94
                                                       95       96       97       98       99      100      101      102
                                                      103      104      105      147
  3246  CFA11        REAL                 C         REFS       50    2*109      110      175      201
  3252  CFA12        REAL                 C         REFS       51    2*109      110      175      201
  3256  CFA13        REAL                 C         REFS       52      109      175      201
  3262  CFA21        REAL                 C         REFS       53      125      129      132      176      202
  3266  CFA22        REAL                 C         REFS       54      125      129      132      176      202
  3272  CFA23        REAL                 C         REFS       55      109      126      129      132      176      202
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VARIABLES      SN  TYPE            RELOCATION
 3276  CFA31       REAL                C        REFS       55      127      130      133      177      203
 3302  CFA32       REAL                C        REFS       57      127      130      133      177      203
 3306  CFA33       REAL                C        REFS       58      108      127      130      133      177      203
 3326  GRAD        REAL                C        REFS       59      117      118      119
  443  DUM         REAL                         REFS      165      163
  423  DX301       REAL                         REFS      122   DEFINED     117
  424  DY301       REAL                         REFS      123   DEFINED     118
  425  DZ301       REAL                         REFS      124   DEFINED     119
 3031  GSPOTY      REAL                C        REFS       39      164
 3043  GSPOTZ      REAL                C        REFS       44      163
  441  I           INTEGER                      REFS      162      163      167   DEFINED     161
  442  IDD         INTEGER                      REFS      165      163   DEFINED     162
 7210  ITST        INTEGER             C        REFS       36      161
 7250  ITNDX       INTEGER    ARRAY    C        REFS       35       49      163      167
 3343  PI          REAL                C        REFS       66      118      119
 2574  Q3URN       REAL                C        REFS       11      206
 2444  RAIL        REAL                C        REFS       10      206
  562  RANGE       REAL                C        REFS       97      194      193   DEFINED     183
  573  RANGO       REAL                C        REFS      101      206   DEFINED     151
 3142  RDELX       REAL                C        REFS       18      172      179    2*180      186      192
                                             DEFINED      143
 3143  RDELY       REAL                C        REFS       19      173      179    2*180      186      192
                                             DEFINED      144
 3144  RDELZ       REAL                C        REFS       20      174      181      183      187      193
                                             DEFINED      145
 3217  RSJYMC      REAL                C        REFS       30      173   DEFINED     164
 3220  RSJZMC      REAL                C        REFS       31      174   DEFINED     168
 3221  RSPOTX      REAL                C        REFS       32      175      176      177   DEFINED     172
 3222  RSPOTY      REAL                C        REFS       33      175      176      177   DEFINED     173
 3223  RSPOTZ      REAL                C        REFS       34      175      176      177   DEFINED     174
 3162  RTXE        REAL                C        REFS       21      143
 3166  RTYE        REAL                C        REFS       22      144
 3172  RTZE        REAL                C        REFS       23      145
 3030  RX          REAL                C        REFS       38      165
  563  RX3A        REAL                C        REFS       98   DEFINED     175
 3116  RXE         REAL                C        REFS       15      143      148
  605  RXL         REAL                C        REFS      102      151   DEFINED     148
 3203  RX3         REAL                C        REFS       24      148
 3042  RY          REAL                C        REFS       43      170
  564  RY3A        REAL                C        REFS       99   DEFINED     176
 3122  RYE         REAL                C        REFS       16      144      149
  606  RYL         REAL                C        REFS      103      151   DEFINED     149
 3204  RY3         REAL                C        REFS       25      149
  565  RZ3A        REAL                C        REFS      100   DEFINED     177
 3126  RZE         REAL                C        REFS       17      145      150
  607  RZL         REAL                C        REFS      104      151   DEFINED     150
 3205  RZ3         REAL                C        REFS       26      150
 3344  R1          REAL                C        REFS       67      117      119
 3035  SXP         REAL                C        REFS       41      164      166
 3032  SXPD        REAL                C        REFS       40      165
 3027  SXPDD       REAL                C        REFS       37   DEFINED     166
 3047  SYP         REAL                C        REFS       46      168      170
 3044  SYPD        REAL                C        REFS       45      170
 3041  SYPDD       REAL                C        REFS       42   DEFINED     170
 3717  T           REAL                C        REFS       77      122      123      124      148      149      150
  444  UVP1        REAL                         REFS      191      193   DEFINED     179
  445  UVP2        REAL                         REFS      182      183      133   DEFINED     188
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     SUBROUTINE G5         74/74    OPT=1                         FTN 4.2+74355       07/07/75  11.05.44.       PAGE     7

VARIABLES      SN  TYPE            RELOCATION
   446  UVP3       REAL                              REFS      191    DEFINED      181
   447  UVP4       REAL                              REFS      187      192        193      DEFINED      182
   316  VAIRSP     REAL                C             REFS        9
   453  VMMU       REAL                              REFS      207      203      DEFINED      201
   454  VMMV       REAL                              REFS      208    DEFINED      202
   455  VMMW       REAL                              REFS      207    DEFINED      203
   307  VMMXE      REAL                C             REFS        6      201        202        203
   310  VMMYE      REAL                C             REFS        7      201        202        203
   311  VMMZE      REAL                C             REFS        8      201        202        203
   543  VTOTE      REAL                C             REFS       86      190      DEFINED      142
  3102  VXE        REAL                C             REFS       12    2*142        152        179        192      2*197      198
   436  VXL      * REAL                           DEFINED      152
  3206  VXO        REAL                C             REFS       27      148        152
   450  VXP        REAL                              REFS      194      195      DEFINED      191
  3106  VYE        REAL                C             REFS       13    2*142        153        179        192      2*197      198
   437  VYL      * REAL                           DEFINED      153
  3207  VYO        REAL                C             REFS       28      149        153
   451  VYP        REAL                              REFS      195    DEFINED      192
  3112  VZE        REAL                C             REFS       14    2*142        154        181        193        197
   440  VZL      * REAL                           DEFINED      154
  3210  VZO        REAL                C             REFS       29      150        154
   452  VZP        REAL                              REFS      194    DEFINED      193
  3053  WO         REAL                C             REFS       48    3*156      3*170
  3347  XB01       REAL                C             REFS       60      113        136        137      DEFINED      122
  3352  XB02       REAL                C             REFS       63
  3350  YB01       REAL                C             REFS       61      113        136        137      DEFINED      123
  3353  YB02       REAL                C             REFS       64
   434  YB1        REAL                              REFS      139    DEFINED      136
  3351  ZB01       REAL                C             REFS       62      117        118        136        137
                                                  DEFINED      124
  3354  ZB02       REAL                C             REFS       65
   435  ZB1        REAL                              REFS      139    DEFINED      137
  3052  ZETA       REAL                C             REFS       47      165        170

EXTERNALS           TYPE   ARGS        REFERENCES
        ATAND       REAL     2              108        109        110        139        186        187        194        195        197
                                            198        207        208        212
        MCARLO               3              165        169
        SQRT        REAL     1 LIBRARY      109        142        151        182        183        197        213

STATEMENT LABELS              DEF LINE   REFERENCES
   147  20                       155       147
   341  30                       213       190        206        211
   201  500                      171       151        167
   165  501                      167       163

LOOPS  LABEL    INDEX      FROM-TO      LENGTH      PROPERTIES
   150  500    * I          161 171      348                     EXT REFS

COMMON BLOCKS   LENGTH      MEMBERS - BIAS NAME(LENGTH)
        C         3830              0 C       (3830)

EQUIV CLASSES   LENGTH      MEMBERS - BIAS NAME(LENGTH)
C       C         3830            199 VMMXE   (1)                    200 VMMYE   (1)                  201 VMMZE   (1)
                                  206 VAIRSP  (1)                    349 BTHT    (1)                  350 BPSI    (1)
                                  351 BPHI    (1)                    352 BPH1    (1)                  353 BTH2    (1)
                                  354 BPS1    (1)                    355 VTOTE   (1)                  356 BGAMM   (1)
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SUBROUTINE G5        74/74   OPT=1                    FTN 4.2+74355      07/07/76  11.05.44.      PAGE    8

EQUIV CLASSES   LENGTH    MEMBERS - BIAS NAME(LENGTH)
                               357 BGAMV   (1)           362 BTHLW   (1)           353 BPSLV   (1)
                               364 BLAMV   (1)           365 BLAMH   (1)           356 BALPHA  (1)
                               367 BALPHY  (1)           368 BALPHP  (1)           359 BPHIP   (1)
                               370 RANGE   (1)           371 RXBA    (1)           372 RYBA    (1)
                               373 RZBA    (1)           379 RANGO   (1)           389 RXL     (1)
                               390 RYL     (1)           391 RZL     (1)           392 BPH2    (1)
                              1316 RAIL    (1)          1404 QBURN   (1)          1533 SXPDD   (1)
                              1560 RX      (1)          1561 GSPOTY  (1)          1552 SXPD    (1)
                              1565 SXP     (1)          1569 SYPDD   (1)          1570 RY      (1)
                              1571 GSPOTZ  (1)          1572 SYPD    (1)          1575 SYP     (1)
                              1578 ZETA    (1)          1579 W0      (1)          1602 VXE     (1)
                              1606 VYE     (1)          1610 VZE     (1)          1614 RXE     (1)
                              1618 RYE     (1)          1622 RZE     (1)          1634 RDELX   (1)
                              1635 RDELY   (1)          1636 RDELZ   (1)          1650 RTXE    (1)
                              1654 RTYE    (1)          1658 RTZE    (1)          1657 RXO     (1)
                              1668 RYO     (1)          1669 RZO     (1)          1670 VXO     (1)
                              1671 VYO     (1)          1672 VZO     (1)          1679 RSJYMC  (1)
                              1680 RSJZMC  (1)          1681 RSPOTX  (1)          1682 RSPOTY  (1)
                              1683 RSPOTZ  (1)          1702 CFA11   (1)          1705 CFA12   (1)
                              1710 CFA13   (1)          1714 CFA21   (1)          1718 CFA22   (1)
                              1722 CFA23   (1)          1726 CFA31   (1)          1730 CFA32   (1)
                              1734 CFA33   (1)          1750 CRAD    (1)          1754 A021    (1)
                              1755 A022    (1)          1756 A023    (1)          1757 A031    (1)
                              1758 A032    (1)          1759 A033    (1)          1760 A011    (1)
                              1761 A012    (1)          1762 A013    (1)          1763 P1      (1)
                              1764 R1      (1)          1767 XB01    (1)          1768 YB01    (1)
                              1769 ZB01    (1)          1770 XB02    (1)          1771 YB02    (1)
                              1772 ZB02    (1)          1999 T       (1)          3720 ITCT    (1)
                              3752 ITNDX   (10)

STATISTICS
  PROGRAM LENGTH                456B     302
  CM LABELED COMMON LENGTH    73663B    3830
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```
      SUBROUTINE SPOTI                                                  SPOT   2
      COMMON /C/ C(3830)                                                SPOT   3
      EQUIVALENCE (C(2561),N     )                                      SPOT   4
      EQUIVALENCE (C(2562),IPL   )                                      SPOT   5
      DIMENSION IPL(100), ISNDX(40), ITNDX(10)                          SPOT   6
      EQUIVALENCE (C(3634), ISNDX),  (C(3512), I3512)                   SPOT   7
      EQUIVALENCE (C(1680),RSJYMC)                                      SPOT   8
      EQUIVALENCE (C(1681),RSJZMC)                                      SPOT   9
      EQUIVALENCE (C(3753),ITNDX), (C(3721), ITCT)                      SPOT  10
      EQUIVALENCE (C(1562),GSPOTY)                                      SPOT  11
      EQUIVALENCE (C(1572),GSPOTZ)                                      SPOT  12
      EQUIVALENCE (C(1581),SIGSPOT)                                     SPOT  13
      EQUIVALENCE (C(1579),    ZETA)                                    SPOT  14
      EQUIVALENCE (C(1580),      W0)                                    SPOT  15
C                                                                       SPOT  16
      DATA W0,ZETA/3.94,0.745/                                          SPOT  17
C                                                                       SPOT  18
C* ZERO OUT SPOT JITTER MAX/MIN STORAGE LOCATIONS THAT ARE SAVED IN OUTP SPOT  19
      C(1567) = 0.                                                      SPOT  20
      C(1568) = 0.                                                      SPOT  21
      C(1577) = 0.                                                      SPOT  22
      C(1578) = 0.                                                      SPOT  23
C  PRINTED FROM MODULE G4                                               SPOT  24
C                                                                       SPOT  25
C SPOT JITTER MONTE CARLO INITIAL VALUES                                SPOT  26
C                                                                       SPOT  27
      RSJYMC = 0.                                                       SPOT  28
      RSJZMC = 0.                                                       SPOT  29
      DO 500 IOL=1,ITCT                                                 SPOT  30
      ITSNDX = IOL                                                      SPOT  31
      IF(ITNDX(IOL).NE.1680) GO TO 502                                  SPOT  32
      IPL(N)=1560                                                       SPOT  33
      IPL(N+1)=1563                                                     SPOT  34
      N=N+2                                                             SPOT  35
      IF(SIGSPOT.NE.0.)                                                 SPOT  36
     1  GSPOTY = .707*SIGSPOT/SQRT(W0/4./ZETA * C(2664))                SPOT  37
      CALL MCARLO(RNSTRT,4,ITSNDX)                                      SPOT  38
  502 IF(ITNDX(IOL).NE.1681) GO TO 500                                  SPOT  39
      IPL(N)=1570                                                       SPOT  40
      IPL(N+1)=1573                                                     SPOT  41
      N=N+2                                                             SPOT  42
      IF(SIGSPOT.NE.0.)                                                 SPOT  43
     1  GSPOTZ = .707*SIGSPOT/SQRT(W0/4./ZETA * C(2664))                SPOT  44
      CALL MCARLO(RNSTRT,4,ITSNDX)                                      SPOT  45
  500 CONTINUE                                                          SPOT  46
C                                                                       SPOT  47
      C(1563)=0.   $   C(1566)=0.   $   C(1573)=0.   $   C(1576)=0.     SPOT  48
      RETURN                                                            SPOT  49
      END                                                               SPOT  50
```

CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
32	I	ITGT	THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.
33	I	ITGT	THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.
39	I	ITCT	THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.
40	I	ITCT	THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.

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SUBROUTINE SPOTI      74/74   OPT=1                        FTN 4.2+74355      07/07/75  11.05.52.      PAGE    3

        SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE      REFERENCES
   1  SPOTI            1            43

VARIABLES        SN  TYPE            RELOCATION
    0  C             REAL        ARRAY    C            REFS        2        3        4      2*5        7        8      2*9
                                                                  10       11       12       13       14       35       42
                                                               DEFINED       19       20       21       22     4*47
 3031  GSPOTY        REAL                 C            REFS       10  DEFINED       35
 3043  GSPOTZ        REAL                 C            REFS       11  DEFINED       42
   64  IOL           INTEGER                           REFS       30       31       38  DEFINED       29
 3001  IPL           INTEGER     ARRAY    C            REFS        4        5  DEFINED       32       33       39       40
 7061  ISNOX         INTEGER     ARRAY    C            REFS        5        5
 7210  ITCT          INTEGER              C            REFS        9       29
 7230  ITNOX         INTEGER     ARRAY    C            REFS        5        9       31       38
   65  ITSNOX        INTEGER                           REFS       37       44  DEFINED       38
 3007  I3512         INTEGER              C            REFS        6
 3000  N             INTEGER              C            REFS        3       32       33       34       39       40       41
                                                               DEFINED       34       41
   66  RNSTRT        REAL                              REFS       37       44
 3217  RSJYMC        REAL                 C            REFS        7  DEFINED       27
 3220  RSJZMC        REAL                 C            REFS        8  DEFINED       28
 3054  SIGSPOT       REAL                 C            REFS       12     2*35     2*42
 3053  WO            REAL                 C            REFS       14       35       42  DEFINED       16
 3052  ZETA          REAL                 C            REFS       13       35       42  DEFINED       16

EXTERNALS            TYPE    ARGS          REFERENCES
      MCARLO                   3                37       44
      SQRT           REAL      1 LIBRARY        35       42

STATEMENT LABELS                   DEF LINE     REFERENCES
   47  500                            45           29       38
   27  502                            38           31

LOOPS  LABEL     INDEX       FROM-TO      LENGTH      PROPERTIES
    7  500     * IOL          29 45        43B                 EXT REFS

COMMON BLOCKS    LENGTH       MEMBERS - BIAS NAME(LENGTH)
      C           3830                 0 C        (3830)

EQUIV CLASSES    LENGTH       MEMBERS - BIAS NAME(LENGTH)
    C      C          3830             1561 GSPOTY  (1)               1571 GSPOTZ (1)              1578 ZETA    (1)
                                       1579 WO      (1)               1580 SIGSPOT(1)              1679 RSJYMC  (1)
                                       1680 RSJZMC  (1)               2560 N      (1)              2551 IPL     (100)
                                       3511 I3512   (1)               3633 ISNOX  (40)             3720 ITCT    (1)
                                       3752 ITNOX   (10)

STATISTICS
  PROGRAM LENGTH                    673B       55
  CM LABELED COMMON LENGTH        7366B      3830
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```
      SUBROUTINE SPOT                                                   SPOT    51
      COMMON /C/ C(3830)                                                SPOT    52
C                                                                       SPOT    53
      EQUIVALENCE (C(1580),RSJYMC)                                      SPOT    54
      EQUIVALENCE (C(1581),RSJZMC)                                      SPOT    55
      EQUIVALENCE (C(1682),RSPOTX)                                      SPOT    56
      EQUIVALENCE (C(1683),RSPOTY)                                      SPOT    57
      EQUIVALENCE (C(1684),RSPOTZ)                                      SPOT    58
      EQUIVALENCE (C(3753), ITNDX)                                      SPOT    59
      EQUIVALENCE (C(3721),  ITCT)                                      SPOT    60
      EQUIVALENCE (C(1560), SXPDD)                                      SPOT    61
      EQUIVALENCE (C(1561),    RX)                                      SPOT    62
      EQUIVALENCE (C(1562),GSPOTY)                                      SPOT    63
      EQUIVALENCE (C(1563),  SXPD)                                      SPOT    64
      EQUIVALENCE (C(1566),   SXP)                                      SPOT    65
      EQUIVALENCE (C(1570), SYPDD)                                      SPOT    66
      EQUIVALENCE (C(1571),    RY)                                      SPOT    67
      EQUIVALENCE (C(1572),GSPOTZ)                                      SPOT    68
      EQUIVALENCE (C(1573),  SYPD)                                      SPOT    69
      EQUIVALENCE (C(1576),   SYP)                                      SPOT    70
      EQUIVALENCE (C(1579),  ZETA)                                      SPOT    71
      EQUIVALENCE (C(1580),    W0)                                      SPOT    72
      DIMENSION ITNDX(10)                                               SPOT    73
C LINE OF SIGHT OF LASER SPOT WITH MONTE CARLO SPOT JITTER INCLUDED     SPOT    74
C                                                                       SPOT    75
      DO 500 I = 1, ITCT                                                SPOT    76
      IDO = I                                                           SPOT    77
      IF(ITNDX(I).NE.1680) GO TO 501                                    SPOT    78
      RSJYMC = GSPOTY*SXP                                               SPOT    79
      CALL MCARLO (DUM,2,IDO)                                           SPOT    80
      SXPDD = W0*W0*(RX-2.*ZETA*SXPD/W0 - SXP)                          SPOT    81
  501 IF(ITNDX(I).NE.1681) GO TO 500                                    SPOT    82
      RSJZMC = GSPOTZ*SYP                                               SPOT    83
      CALL MCARLO (DUM,2,IDO)                                           SPOT    84
      SYPDD = W0*W0*(RY - 2.*ZETA*SYPD/W0 - SYP)                        SPOT    85
  500 CONTINUE                                                          SPOT    86
      RETURN                                                            SPOT    87
      END                                                               SPOT    88
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      SUBROUTINE SPOT        74/74    OPT=1                          FTN 4.2+74355        07/07/75  11.05.53.        PAGE    2

      SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS       DEF LINE      REFERENCES
    1  SPOT              1          37

 VARIABLES       SN  TYPE              RELOCATION
      0  C             REAL        ARRAY    C          REFS        2        4        5        6        7        8        9
                                                         10       11       12       13       14       15       16       17
                                                         18       19       20       21       22
     47  DUM           REAL                            REFS       30       34
   3031  GSPOTY        REAL                 C          REFS       13       29
   3043  GSPOTZ        REAL                 C          REFS       18       33
     45  I             INTEGER                         REFS       27       28       32   DEFINED       26
     46  IDD           INTEGER                         REFS       30       34   DEFINED       27
   7210  ITCT          INTEGER              C          REFS       10       26
   7250  ITNDX         INTEGER     ARRAY    C          REFS        9       23       28       32
   3217  RSJYMC        REAL                 C          REFS        4   DEFINED      29
   3220  RSJZMC        REAL                 C          REFS        5   DEFINED      33
   3221  RSPOTX        REAL                 C          REFS        6
   3222  RSPOTY        REAL                 C          REFS        7
   3223  RSPOTZ        REAL                 C          REFS        8
   3030  RX            REAL                 C          REFS       12       31
   3042  RY            REAL                 C          REFS       17       35
   3035  SXP           REAL                 C          REFS       15       23       31
   3032  SXPD          REAL                 C          REFS       14       31
   3027  SXPDD         REAL                 C          REFS       11   DEFINED      31
   3047  SYP           REAL                 C          REFS       20       33       35
   3044  SYPD          REAL                 C          REFS       19       35
   3041  SYPDD         REAL                 C          REFS       16   DEFINED      35
   3353  WO            REAL                 C          REFS       22     3*31     3*35
   3052  ZETA          REAL                 C          REFS       21       31       35

 EXTERNALS          TYPE   ARGS        REFERENCES
        MCARLO               3             30       34

 STATEMENT LABELS             DEF LINE    REFERENCES
     34  503                     30          26       32
     20  501                     32          28

 LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
     3  500    * I         26 36      34B                   EXT REFS

 COMMON BLOCKS    LENGTH    MEMBERS - BIAS NAME(LENGTH)
        C          3830               0 C      (3830)

 EQUIV CLASSES    LENGTH    MEMBERS - BIAS NAME(LENGTH)
 C      C          3830          1559 SXPDD   (1)           1560 RX      (1)           1551 GSPOTY  (1)
                                 1562 SXPD    (1)           1565 SXP     (1)           1559 SYPDD   (1)
                                 1570 RY      (1)           1571 GSPOTZ  (1)           1572 SYPD    (1)
                                 1575 SYP     (1)           1578 ZETA    (1)           1579 WO      (1)
                                 1679 RSJYMC  (1)           1680 RSJZMC  (1)           1581 RSPOTX  (1)
                                 1682 RSPOTY  (1)           1683 RSPOTZ  (1)           3720 ITCT    (1)
                                 3752 ITNDX   (10)

 STATISTICS
   PROGRAM LENGTH                 50B       40
   CM LABELED COMMON LENGTH     73660     3830
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```
      SUBROUTINE A1                                                    A1       2
      COMMON /C/ C(3830)                                               A1       3
      COMMON /NOS/NCX(6),NCN(4),NCO(2),NCO(6)                          A1       4
      COMMON /CXARG/CXA(9) /CZARG/CZA(10) /CXOARG/CXB(8) /CLDARG/CLA(14) A1     5
      COMMON /CXFUN/CXF(18) /CZFUN/CZF(24) /DCZFUN/DCF(24)             A1       6
     */CMFUN/CMF(24) /DCMFUN/DMF(24) /CXOFUN/COF(8) /CN2FUN/C2F(24)    A1       7
     */CY2FUN/CYP(24) /CL2FUN/CLF(24) /CL3FUN/C3F(24) /CZ0FUN/CDF(92)  A1       8
     */CMDFUN/MDF(92) /CLDFUN/DLF(92) /CMQFUN/CQF(24) /CLPFUN/CPF(24)  A1       9
C** INPUT DATA                                                         A1      10
C**INPUTS FROM OTHER MODULES                                           A1      11
      EQUIVALENCE (C(0204),VMACH )                                     A1      12
      EQUIVALENCE (C(0367),BALPHA)                                     A1      13
      EQUIVALENCE (C(0368),BALPHY)                                     A1      14
      EQUIVALENCE(C(369),BALPHP)                                       A1      15
      EQUIVALENCE (C(0370),BPHIP )                                     A1      16
      EQUIVALENCE (C(1103),BSURF1)                                     A1      17
      EQUIVALENCE (C(1107),BSURF2)                                     A1      18
      EQUIVALENCE (C(1111),BSURF3)                                     A1      19
      EQUIVALENCE (C(1115),BSURF4)                                     A1      20
C**INPUTS FROM MAIN PROGRAM                                            A1      21
      EQUIVALENCE (C(2000),T      )                                    A1      22
      EQUIVALENCE (C(2664),DER    )                                    A1      23
C**OUTPUTS - COEFFICIENTS FOR BODY FORCES                              A1      24
      EQUIVALENCE (C(1203),CX     )                                    A1      25
      EQUIVALENCE (C(1212),CX0    )                                    A1      26
      EQUIVALENCE (C(1213),CXC    )                                    A1      27
      EQUIVALENCE (C(1214),CNPT   )                                    A1      28
      EQUIVALENCE (C(1215),CY2    )                                    A1      29
      EQUIVALENCE (C(1230),BDEFL  )                                    A1      30
      EQUIVALENCE (C(1235),CDCN   )                                    A1      31
      EQUIVALENCE (C(1244),CNPU   )                                    A1      32
      EQUIVALENCE (C(1245),CYPU   )                                    A1      33
C**OUTPUTS - COEFFICIENTS FOR BODY MOMENTS                             A1      34
      EQUIVALENCE (C(1206),CLP    )                                    A1      35
      EQUIVALENCE (C(1207),CMQ    )                                    A1      36
      EQUIVALENCE (C(1208),CNR    )                                    A1      37
      EQUIVALENCE (C(1209),CL     )                                    A1      38
      EQUIVALENCE (C(1210),CM     )                                    A1      39
      EQUIVALENCE (C(1211),CN     )                                    A1      40
      EQUIVALENCE (C(1217),CM0    )                                    A1      41
      EQUIVALENCE (C(1218),CN2    )                                    A1      42
      EQUIVALENCE (C(1234),CDCM)                                       A1      43
      EQUIVALENCE (C(1240),CL2    )                                    A1      44
      EQUIVALENCE (C(1241),CL3    )                                    A1      45
      EQUIVALENCE (C(1247),CMP    )                                    A1      46
      EQUIVALENCE (C(1248),CNP    )                                    A1      47
      EQUIVALENCE (C(1249),CLR    )                                    A1      48
C**OUTPUTS - COEFFICIENTS FOR SURFACE EFFECTS, AND TOTAL EFFECTS       A1      49
      EQUIVALENCE (C(1204),CY     )                                    A1      50
      EQUIVALENCE (C(1205),CZ     )                                    A1      51
      EQUIVALENCE (C(1219),CZQ    )                                    A1      52
      EQUIVALENCE (C(1220),CZR    )                                    A1      53
      EQUIVALENCE (C(1221),CMDQP  )                                    A1      54
      EQUIVALENCE (C(1222),CMR    )                                    A1      55
      EQUIVALENCE (C(1223),CYR    )                                    A1      56
      EQUIVALENCE (C(1224),CYQ    )                                    A1      57
      EQUIVALENCE (C(1225),CLDRP  )                                    A1      58
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      EQUIVALENCE (C(1226),CNQ   )
      EQUIVALENCE (C(1227),CLD   )
      EQUIVALENCE (C(1228),CLMP  )
      EQUIVALENCE (C(1229),CLNP  )
      EQUIVALENCE (C(1231),BOL)
      EQUIVALENCE (C(1232),BDM)
      EQUIVALENCE (C(1233),BON)
      EQUIVALENCE (C(1250),CZP   )
      EQUIVALENCE (C(1251),CYP   )
      EQUIVALENCE (C(1271),BDNO  )
      EQUIVALENCE (C(1270),BDMO  )
      DATA UTIME,USPHI,UCPHI,US2PHI /0.0,0.0,0.0,0.0/
      DATA US2PH2,US4PHI,UALPHA,UALPHY,BDMP /0.0,0.0,0.0,0.0,0.0/
C  INPUT VARIABLE XINTER IS THE INTERPOLATION CONTROL
C    LESS THAN ZERO - STRAIGHT LINE INTERPOLATION
C    POSITIVE - PARABOLIC INTERPOLATION , WITH END INTERVAL
C             INTERPOLATION    (0. TO 1.)
C             0.0 - STRAIGHT LINE
C
C
1     CONTINUE
      IF (T.LE.DER) UTIME= 0.
      IF (T-UTIME .LE. 0.) RETURN
      UTIME= T
C  MULTIPLE ANGLE FORMULAE AND ABSOLUTE VALUES OF ANGLE OF ATTACK
      USPHI = SIND(BPHIP)
      UCPHI = COSD(BPHIP)
      US2PHI = SIND ( 2. * BPHIP )
      US2PH2 = US2PHI ** 2
      US4PHI = SIND ( 4. * BPHIP )
      IF(ABS(BALPHP) .GT. 20.)BALPHP=20.
      IF(ABS(BALPHA) .GT. 20.)BALPHA=20.
      IF(ABS(BALPHY) .GT. 20.)BALPHY=20.
      UALPHA = ABS(BALPHA)
      UALPHY = ABS(BALPHY)
      XINTER=0.
      CALL TABLE(VMACH,CX0,CO*,NC0,XINTER,3HCX0,CX0)
      XINTER=0
      CALL TABL2(BALPHP,VMACH,CXA,CXF,NCX,XINTER,3HCXC,CXC)
      XINTER=0
      CALL TABL2(BALPHP,VMACH,CZA,CZF,NCN,XINTER,4HCNPT,CNPT)
      CALL TABL2(BALPHP,VMACH,CZA,DCF,NCN,XINTER,4HCDCN,CDCN)
      CALL TABL2(BALPHP,VMACH,CZA,CYF,NCN,XINTER,4H CY2, CY2)
      CX=CX0+CXC
      CNPJ=CNPT+CDCN*US2PH2
      CYPJ = CY2*US4PHI
C  CALCULATION OF BODY MOMENT COEFFICIENTS
      CALL TABL2(BALPHP,VMACH,CZA,CLF,NCN,XINTER,4H CL2, CL2)
      CALL TABL2(BALPHP,VMACH,CZA,C3F,NCN,XINTER,4H CL3, CL3)
      CALL TABL2(BALPHP,VMACH,CZA,CMF,NCN,XINTER,4H CM0, CM0)
      CALL TABL2(BALPHP,VMACH,CZA,DMF,NCN,XINTER,4HCDCM,CDCM)
      CALL TABL2(BALPHP,VMACH,CZA,C2F,NCN,XINTER,4H CN2, CN2)
      CALL TABL2(BALPHP,VMACH,CZA,CPF,NCN,XINTER,4H CLP, CLP)
      CALL TABL2(UALPHA,VMACH,CZA,CQF,NCN,XINTER,4H CMQ, CMQ)
      CALL TABL2(UALPHY,VMACH,CZA,CQF,NCN,XINTER,4HCNR , CNR)
      XINTER=0
      CLR = CL2*US4PHI + CL3*USPHI
```

```
      CMP = CM0+CDCN*US2PH2
      CNP = CN2*US4PHI
C**CALCULATION OF SURFACE COEFFICIENTS
      BDL = (-BSURF1-BSURF2+BSURF3+BSURF4)/4.
      BDM = ( BSURF1+BSURF2+BSURF3+BSURF4)/4.
      BDN = (-BSURF1+BSURF2-BSURF3+BSURF4)/4.
      XINTER=0.
      CALL TABL3(BALPHP,BDM,VMACH,CLA,CDF,NCD,XINTER,4H CZQ, CZQ)
      XINTER=0.
      CALL TABL3(BALPHP,BDN,VMACH,CLA,CDF,NCD,XINTER,4H CYR, CYR)
      XINTER=0.
      CALL TABL3(BALPHP,BDN,VMACH,CLA,MDF,NCD,XINTER,4H CMR, CMR)
      XINTER=0.
      CALL TABL3(BALPHP,BDM,VMACH,CLA,MDF,NCD,XINTER,4H CNQ, CNQ)
      XINTER=0.
      CALL TABL3(BALPHP,BDL,VMACH,CLA,DLF,NCD,XINTER,4H CLD, CLD)
      CZP=(CNPU+CZQ*UCPHI*BDM-CYR*USPHI*BDN)
      CYP=(CYPU+CYR*UCPHI*BDN+CZQ*USPHI*BDM)
      CL=(CLR+CLD*BDL)
      CLMP=(CMP+CNQ*UCPHI*BDM-CMR*USPHI*BDN)
      CLNP=(CNP+CMR*UCPHI*BDN+CNQ*USPHI*BDM)
C** TRANSFORMATION FROM WIND TO BODY AXIS
      CY = CYP*UCPHI-CZP*USPHI
      CZ = -CZP*UCPHI-CYP*USPHI
      CM = CLMP*UCPHI+CLNP*USPHI
      CN = CLNP*UCPHI-CLMP*USPHI
      RETURN
      END
```

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SUBROUTINE A1          74/74   OPT=1                    FTN 4.2+74355      07/07/75  11.05.55.     PAGE    4

      SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS      DEF LINE     REFERENCES
   1  A1               1          80        141

 VARIABLES      SN  TYPE             RELOCATION
    556  BALPHA      REAL                 C          REFS        12        89        91   DEFINED        89
    560  BALPHP      REAL                 C          REFS        14        88        96        98        99       100       105
                                                      106       107       108       109       110       122       124       126
                                                      128       130   DEFINED        88
    557  BALPHY      REAL                 C          REFS        13        90        92   DEFINED        90
   2315  BOEFL       REAL                 C          REFS        29
   2316  BOL         REAL                 C          REFS        62       130       133   DEFINED       110
   2317  BDM         REAL                 C          REFS        63       122       128       131       132       134       135
                                                  DEFINED       119
   2305  BDMO        REAL                 C          REFS        68
   2320  BDN         REAL                 C          REFS        64       124       126       131       132       134       135
                                                  DEFINED       120
   2366  BDNO        REAL                 C          REFS        67
    475  BDNP      * REAL                         DEFINED        70
    561  BPHIP       REAL                 C          REFS        15        83        84        85        87
   2116  BSJRF1      REAL                 C          REFS        16       118       119       120
   2122  BSJRF2      REAL                 C          REFS        17       118       119       120
   2126  BSJRF3      REAL                 C          REFS        18       118       119       120
   2132  BSJRF4      REAL                 C          REFS        19       118       119       120
      0  C           REAL       ARRAY     C          REFS         2        11        12        13        14        15        16
                                                       17        18        19        21        22        24        25        26
                                                       27        28        29        30        31        32        34        35
                                                       36        37        38        39        40        41        42        43
                                                       44        45        46        47        49        50        51        52
                                                       53        54        55        56        57        58        59        60
                                                       61        62        63        64        65        66        67        68
   2321  CDCM        REAL                 C          REFS        42       103       115
   2322  CDCN        REAL                 C          REFS        30        99       102
      0  CDF         REAL       ARRAY     CZDFUN     REFS         5       122       124
   2270  CL          REAL                 C          REFS        37   DEFINED       133
      0  CLA         REAL       ARRAY     CLDARG     REFS         4       122       124       126       128       130
   2312  CLJ         REAL                 C          REFS        59       130       133
   2310  CLJRP       REAL                 C          REFS        57
      0  CLF         REAL       ARRAY     CLZFUN     REFS         5       105
   2313  CLMP        REAL                 C          REFS        60       139       140   DEFINED       134
   2314  CLNP        REAL                 C          REFS        61       139       140   DEFINED       135
   2265  CLP         REAL                 C          REFS        34       110
   2340  CLR         REAL                 C          REFS        47       133   DEFINED       114
   2327  CL2         REAL                 C          REFS        43       105       114
   2330  CL3         REAL                 C          REFS        44       105       114
   2271  CM          REAL                 C          REFS        38   DEFINED       139
   2304  CMDQP       REAL                 C          REFS        53
      0  CMF         REAL       ARRAY     CMFUN      REFS         5       107
   2336  CMP         REAL                 C          REFS        45       134   DEFINED       115
   2266  CMQ         REAL                 C          REFS        35       111
   2305  CMR         REAL                 C          REFS        54       125       134       135
   2300  CM0         REAL                 C          REFS        40       107       115
   2272  CN          REAL                 C          REFS        39   DEFINED       140
   2337  CNP         REAL                 C          REFS        46       135   DEFINED       116
   2275  CNPT        REAL                 C          REFS        27        98       102
   2333  CNPU        REAL                 C          REFS        31       131   DEFINED       102
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VARIABLES       SN  TYPE              RELOCATION
 2311  CN1          REAL                  C           REFS      58      128      134      135
 2267  CNR          REAL                  C           REFS      36      112
 2301  CN2          REAL                  C           REFS      41      109      116
    0  COF          REAL      ARRAY       CXOFUN      REFS       5       94
    0  CPF          REAL      ARRAY       CLPFUN      REFS       5      110
    0  CQF          REAL      ARRAY       CMQFUN      REFS       5      111      112
 2262  CX           REAL                  C           REFS      24  DEFINED      101
    0  CXA          REAL      ARRAY       CXARG       REFS       4       95
    0  CX3          REAL      ARRAY       CXDARG      REFS       4       94
 2274  CXC          REAL                  C           REFS      26       96      101
    0  CXF          REAL      ARRAY       CXFUN       REFS       5       95
 2273  CX0          REAL                  C           REFS      25       94      101
 2263  CY           REAL                  C           REFS      49  DEFINED      137
    0  CYF          REAL      ARRAY       CY2FUN      REFS       5      100
 2342  CYP          REAL                  C           REFS      66      137      138  DEFINED      132
 2334  CYPU         REAL                  C           REFS      32      132  DEFINED      103
 2307  CY1          REAL                  C           REFS      56
 2306  CYR          REAL                  C           REFS      55      124      131      132
 2276  CY2          REAL                  C           REFS      28      100      103
 2264  CZ           REAL                  C           REFS      50  DEFINED      138
    0  CZA          REAL      ARRAY       CZARG       REFS       4       98       99      100      105      106      107
                                                       108     109      110      111      112
    0  CZF          REAL      ARRAY       CZFUN       REFS       5       98
 2341  CZP          REAL                  C           REFS      65      137      138  DEFINED      131
 2302  CZ1          REAL                  C           REFS      51      122      131      132
 2303  CZR          REAL                  C           REFS      52
    0  C2F          REAL      ARRAY       CN2FUN      REFS       5      109
    0  C3F          REAL      ARRAY       CL3FUN      REFS       5      105
    0  DCF          REAL      ARRAY       DCZFUN      REFS       5       93
 3147  LER          REAL                  C           REFS      22       79
    0  DLF          REAL      ARRAY       CLDFUN      REFS       5      130
    0  DMF          REAL      ARRAY       CDMFUN      REFS       5      108
    0  MDF          INTEGER   ARRAY       CMDFUN      REFS       5      125      128
   14  NCD          INTEGER   ARRAY       NOS         REFS       3      122      124      126      128      130
    6  NCN          INTEGER   ARRAY       NOS         REFS       3       93       99      100      105      106      107
                                                       108     109      110      111      112
   12  NCO          INTEGER   ARRAY       NOS         REFS       3       94
    0  NCX          INTEGER   ARRAY       NOS         REFS       3       95
 3717  T            REAL                  C           REFS      21       79       80       81
  473  UALPHA       REAL                              REFS     111  DEFINED       70       91
  474  UALPHY       REAL                              REFS     112  DEFINED       70       92
  467  UCPHI        REAL                              REFS     131      132      134      135      137      138      139
                                                       140  DEFINED       69       34
  466  USPHI        REAL                              REFS     114      131      132      134      135      137      138
                                                       139     140  DEFINED       69       83
  470  US2PHI       REAL                              REFS      86  DEFINED       69       85
  471  US2P42       REAL                              REFS     102      115  DEFINED       70       86
  472  US4PHI       REAL                              REFS     103      114      116  DEFINED       70       87
  465  UTIME        REAL                              REFS      80  DEFINED       69       79       81
  313  VMACH        REAL                  C           REFS      11       94       96       98       99      100      105
                                                       106     107      108      109      110      111      112      122
                                                       124     126      128      130
  502  XINTER       REAL                              REFS      94       95       98       99      100      105      106
                                                       107     108      109      110      111      112      122      124
                                                       126     128      130  DEFINED       93       95       97      113
                                                       121     123      125      127      129
```

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EXTERNALS        TYPE    ARGS      REFERENCES
     COSD        REAL     1           84
     SIND        REAL     1           83         85         87
     TABLE                7           94
     TABL2                8           96         98         99        100        105        106        107        108        109
                                     110        111        112
     TABL3                9          122        124        126        128        130

INLINE FUNCTIONS  TYPE    ARGS       DEF LINE   REFERENCES
     ABS          REAL     1  INTRIN               88         89         90         91         92

STATEMENT LABELS              DEF LINE    REFERENCES
     0 1          INACTIVE       78

COMMON BLOCKS   LENGTH     MEMBERS - BIAS NAME(LENGTH)
     C           3830               0 C     (3830)
     NOS           18               0 NCX   (6)                 6 NCN     (4)                10 NCJ     (2)
                                   12 NCD   (6)
     CXARG          9               0 CXA   (9)
     CZARG         10               0 CZA   (10)
     CXDARG         8               0 CXB   (8)
     CLDARG        14               0 CLA   (14)
     CXFUN         18               0 CXF   (18)
     CZFUN         24               0 CZF   (24)
     DCZFUN        24               0 DCF   (24)
     CMFUN         24               0 CMF   (24)
     DCMFUN        24               0 DMF   (24)
     CXDFUN         8               0 CDF   (8)
     CN2FUN        24               0 C2F   (24)
     CY2FUN        24               0 CYF   (24)
     CL2FUN        24               0 CLF   (24)
     CL3FUN        24               0 C3F   (24)
     CZDFUN        92               0 CDF   (92)
     CMDFUN        92               0 MDF   (92)
     CLDFUN        92               0 DLF   (92)
     CMQFUN        24               0 CQF   (24)
     CLPFUN        24               0 CPF   (24)

EQUIV CLASSES   LENGTH     MEMBERS - BIAS NAME(LENGTH)
C    C           3830            203 VMACH  (1)           366 BALPHA  (1)           367 BALPHV  (1)
                                 368 BALPHP (1)           369 BPHIP   (1)          1102 BSURF1  (1)
                                1106 BSURF2 (1)          1110 BSURF3  (1)          1114 BSURF4  (1)
                                1202 CK     (1)          1203 CY      (1)          1204 CZ      (1)
                                1205 CLP    (1)          1206 CMQ     (1)          1207 CNR     (1)
                                1208 CL     (1)          1209 CM      (1)          1210 CN      (1)
                                1211 CK0    (1)          1212 CXC     (1)          1213 CNPT    (1)
                                1214 CY2    (1)          1216 CM0     (1)          1217 CN2     (1)
                                1218 CZQ    (1)          1219 CZR     (1)          1220 CMDQP   (1)
                                1221 CMR    (1)          1222 CYR     (1)          1223 CYQ     (1)
                                1224 CLDRP  (1)          1225 CNQ     (1)          1226 CLD     (1)
                                1227 CLMP   (1)          1228 CLNP    (1)          1229 BDEFL   (1)
                                1230 BDL    (1)          1231 BDM     (1)          1232 BDN     (1)
                                1233 CDCM   (1)          1234 CDCN    (1)          1239 CL2     (1)
                                1240 CL3    (1)          1243 CNPU    (1)          1244 CYPU    (1)
                                1246 CMP    (1)          1247 CNP     (1)          1248 CLR     (1)
                                1249 CZP    (1)          1250 CYP     (1)          1259 BDNO    (1)
                                1270 BDNO   (1)          1999 T       (1)          2653 DER     (1)
```

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STATISTICS
  PROGRAM LENGTH                 547B      359
  CM LABELED COMMON LENGTH    105178B     4431
```

SUBROUTINE A3I 74/74 OPT=1 FTN 4.2+74355 07/07/75 11.05.58. PAGE 1

```
      SUBROUTINE A3I
C**INITIALIZATION FOR ENGINE MODULE
      COMMON /C/ C(3830)
      DIMENSION IPL(100), ISNDX(40)
      EQUIVALENCE (C(3634), ISNDX), (C(3512), I3512)
      EQUIVALENCE (C( 367),BALPHA)
      EQUIVALENCE (C( 368),BALPHY)
      EQUIVALENCE (C( 370),BPHIP )
      EQUIVALENCE (C(1308),RDELCG)
      EQUIVALENCE (C(1320),FMXTH )
      EQUIVALENCE (C(1321),FMYTH )
      EQUIVALENCE (C(1322),FMZTH )
      EQUIVALENCE (C(1405),QBURN )
      EQUIVALENCE (C(1411),FTHX  )
      EQUIVALENCE (C(1412),FTHY  )
      EQUIVALENCE (C(1413),FTHZ  )
      EQUIVALENCE (C(1415),DWT   )
      EQUIVALENCE (C(1418),ROCGF )
      EQUIVALENCE (C(1419),FMIXF )
      EQUIVALENCE (C(1420),FMIYF )
      EQUIVALENCE (C(1628),DMASS )
      EQUIVALENCE (C(1739),WP    )
      EQUIVALENCE (C(1743),WQ    )
      EQUIVALENCE (C(1747),WR    )
      EQUIVALENCE (C(1748),FMIX  )
      EQUIVALENCE (C(1749),FMIY  )
      EQUIVALENCE (C(1750),FMIZ  )
      EQUIVALENCE (C(2000),     T)
      EQUIVALENCE (C(2561),N     )
      EQUIVALENCE (C(2562),IPL   )
      EQUIVALENCE (C(1751),    CRAD)
      EQUIVALENCE (C( 626),    VI3)
      EQUIVALENCE (C(1737),    FMX),  (C(1741),    FMY), (C(1745), FMZ)
      DATA IFLG1,IFLG2/0,0/
      IPL(N  ) = 1436
      N = N+1
      C(1439) = 0.
C
      IF (QBURN .GT. 0.) GO TO 10
      CRAD=57.295778
      FMX=0.        $ FMY=0.        $ FMZ=0.
      WP = 0.
      WQ = 0.
      WR = 0.
      BALPHA = 0.
      BALPHY = 0.
      BPHIP = 0.
C
C MONTECARLO THRUST DIRECTION ERRORS
C
      DO 5 I = 1, I3512
      IDO = I
      IF(ISNDX(I).EQ.1313) CALL MCARLO (DUM, 1, IDO)
      IF(ISNDX(I).EQ.1314) CALL MCARLO (DUM, 1, IDO)
      IF(ISNDX(I).EQ.1315) CALL MCARLO (DUM, 1, IDO)
      IF(ISNDX(I).EQ.1401) CALL MCARLO (DUM, 1, IDO)
      IF(ISNDX(I).EQ.1402) CALL MCARLO (DUM, 1, IDO)
```

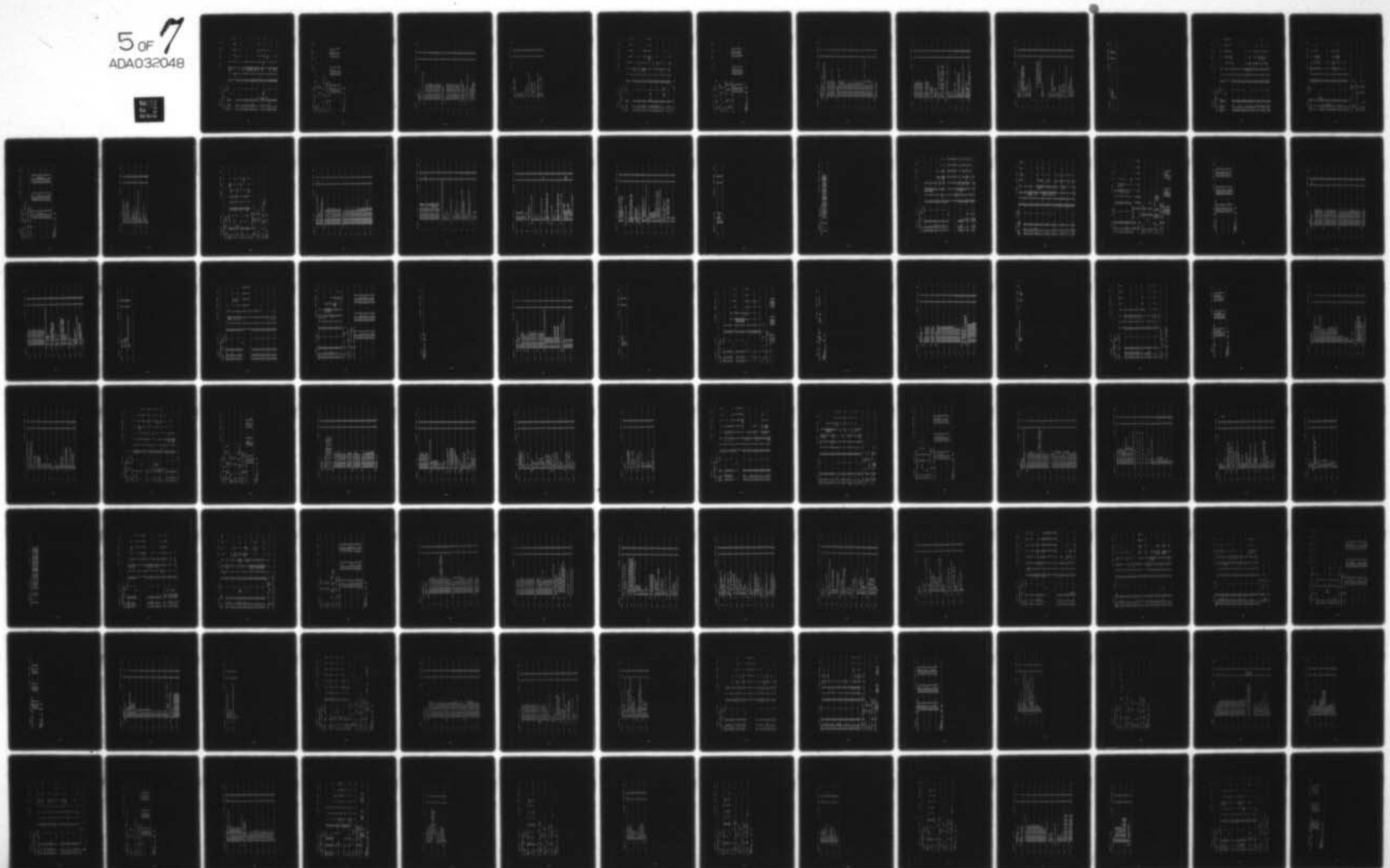
SUBROUTINE A3I   74/74   OPT=1   FTN 4.2+74355   07/07/75 11.05.58.   PAGE

```
      C**MONTE CARLO TIPOFF ROLL,PITCH AND YAW RATES
            IF(ISNOX(I).EQ.1738)CALL MCARLO(DUM,1,IDD)
            IF(ISNOX(I).EQ.1746)IFLG2=0
            IF(ISNOX(I).EQ.1742)IFLG1=0
          5 CONTINUE
      C
            IF(IB.LE.0.)GO TO 6
            CALL LTRAN(T,DELT,C(1746),DUM,WR0,IFLG2,1)
            CALL LTRAN(T,DELT,C(1742),DUM,WQ0,IFLG1,2)
            WQ=WQ0/FMIYF        *CRAD
            WR=WR0/FMIYF        *CRAD
          6 CONTINUE
            IFLG1=1      $ IFLG2=1
      C
            RETURN
         10 CONTINUE
            FTHRST=0.
            FTHX=0.
            FTHY=0.
            FTHZ=0.
            FMXIM=0.
            FMYTH=0.
            FMZTH=0.
            DMASS = DWT/32.174
            ROELCG = ROCGF
            FMIX = FMIXF
            FMIY = FMIYF
            FMIZ = FMIYF
            RETURN
            END
```

AD-A032 048   ARMY MISSILE RESEARCH DEVELOPMENT AND ENGINEERING LAB--ETC   F/G 16/4
THAD T-7 MISSILE MONTE-CARLO TERMINAL HOMING SIMULATION UTILIZI--ETC(U)
JUL 76   C L LEWIS, W R HOOKER, A W LEE

UNCLASSIFIED   RG-7T-2   NL

5 OF 7
ADA032048



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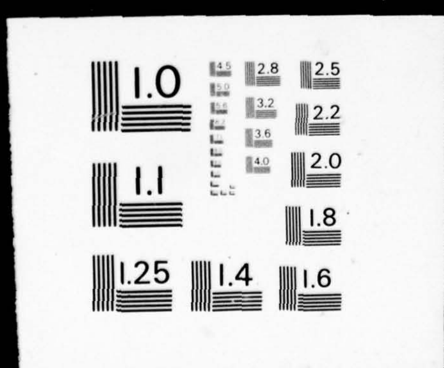
ADA032048



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      SUBROUTINE A31        74/74   OPT=1                           FTN 4.2+74355      07/07/75  11.05.58.       PAGE     3

      SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS        DEF LINE     REFERENCES
   1  A31                 1         72        86

VARIABLES        SN  TYPE           RELOCATION
   556  BALPHA       REAL                 C          REFS         6    DEFINED      45
   557  BALPHY       REAL                 C          REFS         7    DEFINED      46
   561  BPHIP        REAL                 C          REFS         8    DEFINED      47
     0  C            REAL        ARRAY    C          REFS         3      2*5         6        7        8        9       10
                                                       11        12       13        14       15       16       17       18
                                                       19        20       21        22       23       24       25       26
                                                       27        28       29        30       31       32     8*33       65
                                                       66   DEFINED       37
  3326  CRAD         REAL                 C          REFS        31       67        68  DEFINED       48
   146  DELT         REAL                            REFS        65       65
  3133  DMASS        REAL                 C          REFS        21  DEFINED        81
   145  DUM          REAL                            REFS        53       54        55       56       57       59       65
                                                       66
  2606  DWT          REAL                 C          REFS        17       81
  3323  FMIX         REAL                 C          REFS        25  DEFINED        83
  2612  FMIXF        REAL                 C          REFS        19       83
  3324  FMIY         REAL                 C          REFS        26  DEFINED        84
  2613  FMIYF        REAL                 C          REFS        20       67        68       84       85
  3325  FMIZ         REAL                 C          REFS        27  DEFINED        85
  3310  FMX          REAL                 C          REFS        33  DEFINED        41
  2447  FMXTH        REAL                 C          REFS        10  DEFINED        78
  3314  FMY          REAL                 C          REFS        33  DEFINED        41
  2450  FMYTH        REAL                 C          REFS        11  DEFINED        79
  3320  FMZ          REAL                 C          REFS        33  DEFINED        41
  2451  FMZTH        REAL                 C          REFS        12  DEFINED        80
   151  FTHRST   *   REAL                         DEFINED        74
  2602  FTHX         REAL                 C          REFS        14  DEFINED        75
  2603  FTHY         REAL                 C          REFS        15  DEFINED        76
  2604  FTHZ         REAL                 C          REFS        16  DEFINED        77
   143  I            INTEGER                         REFS        52       53        54       55       56       57       59
                                                       60        61  DEFINED       51
   144  IDD          INTEGER                         REFS        53       54        55       56       57       59
                                                  DEFINED        52
   135  IFLG1        INTEGER                         REFS        66  DEFINED        34       61       78
   136  IFLG2        INTEGER                         REFS        65  DEFINED        34       60       78
  3001  IPL          INTEGER     ARRAY    C          REFS         4       30   DEFINED       35
  7061  ISNDX        INTEGER     ARRAY    C          REFS         4        5        53       54       55       56       57
                                                       59        60       61
  6667  I3512        INTEGER              C          REFS         5       51
  3000  N            INTEGER              C          REFS        29       35        36  DEFINED       86
  2574  QBJRN        REAL                 C          REFS        13       89
  2611  RDCGF        REAL                 C          REFS        18       82
  2433  RDELCG       REAL                 C          REFS         9  DEFINED        82
  3717  T            REAL                 C          REFS        28       65        66
  1161  VIB          REAL                 C          REFS        32       64
  3312  WP           REAL                 C          REFS        22  DEFINED        42
  3316  WQ           REAL                 C          REFS        23  DEFINED        43       67
   150  WQ0          REAL                            REFS        66       67
  3322  WR           REAL                 C          REFS        24  DEFINED        44       68
   147  WR0          REAL                            REFS        65       68
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      SUBROUTINE A31        74/74    OPT=1                              FTN 4.2+74355       07/07/75  11.05.58.        PAGE     4

 EXTERNALS          TYPE   ARGS        REFERENCES
        LTRAN                7               65        66
        MCARLO               3               53        54        55        56        57        59

 STATEMENT LABELS                DEF LINE    REFERENCES
      0  5                          62          51
     74  6                          69          64
     76  10                         73          39

 LOOPS  LABEL     INDEX      FROM-TO      LENGTH     PROPERTIES
    16   5          * I        51 62         44B                    EXT REFS

 COMMON BLOCKS    LENGTH      MEMBERS - BIAS NAME(LENGTH)
       C             3830                 0 C        (3830)

 EQUIV CLASSES    LENGTH      MEMBERS - BIAS NAME(LENGTH)
       C             3830             366 BALPHA  (1)           367 BALPHY  (1)           359 BPHIP   (1)
                                      625 VIB     (1)          1307 RDELCG  (1)          1319 FMXTM   (1)
                                     1320 FMYTH   (1)          1321 FMZTH   (1)          1404 QBURN   (1)
                                     1410 FTMX    (1)          1411 FTMY    (1)          1412 FTMZ    (1)
                                     1414 DWT     (1)          1417 RDCGF   (1)          1418 FMIXF   (1)
                                     1419 FMIYF   (1)          1627 OMASS   (1)          1736 FMX     (1)
                                     1738 WP      (1)          1740 FMY     (1)          1742 WQ      (1)
                                     1744 FMZ     (1)          1746 WR      (1)          1747 FMIX    (1)
                                     1748 FMIY    (1)          1749 FMIZ    (1)          1750 CRAD    (1)
                                     1399 T       (1)          2560 N       (1)          2551 IPL     (100)
                                     3511 I3512   (1)          3633 ISNDX   (40)

 STATISTICS
   PROGRAM LENGTH                1528      106
   CM LABELED COMMON LENGTH     73663     3830
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      SUBROUTINE A3                                              A3      89
C**ENGINE MODULE                                                 A3      90
      COMMON /C/ C(3830)                                         A3      91
C                                                                A3      92
      COMMON/NTH/NTH(2) /THARG/THA(20) /THFUN/THF(20)            A3      93
C                                                                A3      94
C** INPUT DATA                                                   A3      95
      EQUIVALENCE (C(1313),RFXCG )                               A3      96
      EQUIVALENCE (C(1314),RFYCG )                               A3      97
      EQUIVALENCE (C(1315),RFZCG )                               A3      98
      EQUIVALENCE (C(1401),BALPHT)                               A3      99
      EQUIVALENCE (C(1402),BPHIT )                               A3     100
      EQUIVALENCE (C(1403),QNALGN)                               A3     101
      EQUIVALENCE (C(1404),PCFTH )                               A3     102
      EQUIVALENCE (C(1405),QBURN )                               A3     103
      EQUIVALENCE (C(1414),CISP  )                               A3     104
      EQUIVALENCE (C(1415),DWT   )                               A3     105
      EQUIVALENCE (C(1416),DWP   )                               A3     106
      EQUIVALENCE (C(1417),RDCGO )                               A3     107
      EQUIVALENCE (C(1418),RDCGF )                               A3     108
      EQUIVALENCE (C(1419),FMIXO)                                A3     109
      EQUIVALENCE (C(1420),FMIYO)                                A3     110
      EQUIVALENCE (C(1421),RLCGO )                               A3     111
C                                                                A3     112
C** INPUTS FROM OTHER MODULES                                    A3     113
      EQUIVALENCE (C(2000),T      )                              A3     114
C                                                                A3     115
C** OUTPUTS                                                      A3     116
      EQUIVALENCE (C(1308),RDELCG)                               A3     117
      EQUIVALENCE (C(1320),FMXTH )                               A3     118
      EQUIVALENCE (C(1321),FMYTH )                               A3     119
      EQUIVALENCE (C(1322),FMZTH )                               A3     120
      EQUIVALENCE (C(1409),UOWP  )                               A3     121
      EQUIVALENCE (C(1410),FTHRST)                               A3     122
      EQUIVALENCE (C(1411),FTHX  )                               A3     123
      EQUIVALENCE (C(1412),FTHY  )                               A3     124
      EQUIVALENCE (C(1413),FTHZ  )                               A3     125
      EQUIVALENCE (C(1422),RLCG  )                               A3     126
      EQUIVALENCE (C(1528),DMASS )                               A3     127
      EQUIVALENCE (C(1748),FMIX  )                               A3     128
      EQUIVALENCE (C(1749),FMIY  )                               A3     129
      EQUIVALENCE (C(1750),FMIZ  )                               A3     130
C                                                                A3     131
C**STATE VARIABLES AND THEIR DERIVATIVES                         A3     132
      EQUIVALENCE (C(1496),UIMPD )                               A3     133
      EQUIVALENCE (C(1499),UIMP  )                               A3     134
C**LOOK UP TABLE FOR THRUST                                      A3     135
C                                                                A3     136
      IF (QBURN.GT.0.) RETURN                                    A3     137
      CALL TABLE(T,THA,THF,NTH,XF,6HFTHRST,FTHRST)               A3     138
C                                                                A3     139
      IF (QNALGN) 20,20,10                                       A3     140
   10 USINA=SIND(BALPHT)                                         A3     141
      FTHX=FTHRST*COSD(BALPHT)                                   A3     142
      FTHY=-FTHRST*USINA*SIND(BPHIT)                             A3     143
      FTHZ=FTHRST*USINA*COSD(BPHIT)                              A3     144
      FMXTH = -FTHY*RFZCG + FTHZ*RFYCG                           A3     145
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      FMYTH =  FTHX*RPZCG + FTHZ*RPXCG
      FMZTH = -FTHX*RPYCG - FTHY*RPXCG
      GO TO 30
   20 FTHX=FTHRST
      FTHY=0.
      FTHZ=0.
      FMXTH=0.
      FMYTH=0.
      FMZTH=0.
   30 CONTINUE
C
      DIMPL = FTHRST
      UDWP = UINP/CISP
C
      DMASS=(DWT-UDWP)/32.174
      RDELCG = RDCGO - (RDCGO - RDCGF)*UDWP/DWP
C
      FMIX=FMIXO*(DWT-UDWP)/DWT
      FMIY=FMIYO*(DWT-UDWP)/DWT
      FMIZ = FMIY
      RLCG = RLCGO + RDELCG
      IF (FTHRST .GT. 0.) RETURN
C
      WRITE (6,100) T
  100 FORMAT (7/14H BURNOUT TIME=,F8.4,5H SEC.)
      QBURN=1.0
      FTHX=0.    $  FTHY=0.    $  FTHZ=0.
      FMXTH=0.   $  FMYTH=0.   $  FMZTH=0.
      RETURN
      END
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        SUBROUTINE A3          74/74   OPT=1                          FTN 4.2+74355      07/07/75  11.05.59.      PAGE     3

        SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS        DEF LINE     REFERENCES
    1  A3               1          49       79       86

 VARIABLES        SN  TYPE             RELOCATION
   2570  BALPHT       REAL                C         REFS       11       53       54
   2571  BPHIT        REAL                C         REFS       12       55       56
      0  C            REAL       ARRAY    C         REFS        3        9        9       10       11       12       13
                                                               14       15       15       17       18       19       20       21
                                                               22       23       25       29       30       31       32       33
                                                               34       35       35       37       38       39       40       41
                                                               42       45       46
   2605  CISP         REAL                C         REFS       16       70
   3133  DMASS        REAL                C         REFS       39    DEFINED     72
   2607  DWP          REAL                C         REFS       18       73
   2606  DWT          REAL                C         REFS       17       72      2*75     2*75
   3323  FMIX         REAL                C         REFS       40    DEFINED     75
   2612  FMIXO        REAL                C         REFS       21       75
   3324  FMIY         REAL                C         REFS       41       77    DEFINED     76
   2613  FMIYO        REAL                C         REFS       22       75
   3325  FMIZ         REAL                C         REFS       42    DEFINED     77
   2447  FMXTH        REAL                C         REFS       30    DEFINED     57       64       65
   2450  FMYTH        REAL                C         REFS       31    DEFINED     58       65       65
   2451  FMZTH        REAL                C         REFS       32    DEFINED     59       66       65
   2601  FTHRST       REAL                C         REFS       34       50       54       55       56       61       69
                                                               79
   2602  FTHX         REAL                C         REFS       35       58       59    DEFINED     54       61       84
   2603  FTHY         REAL                C         REFS       36       57       59    DEFINED     55       62       84
   2604  FTHZ         REAL                C         REFS       37       57       58    DEFINED     56       63       84
      0  NTH          INTEGER    ARRAY    NTH       REFS        5       50
   2573  PCFTH        REAL                C         REFS       14
   2574  QBJRN        REAL                C         REFS       15       49    DEFINED     83
   2572  QNALGN       REAL                C         REFS       13       52
   2611  RODGF        REAL                C         REFS       20       73
   2610  RODGO        REAL                C         REFS       19      2*73
   2433  RDELCG       REAL                C         REFS       29       78    DEFINED     73
   2440  RFXCG        REAL                C         REFS        8       58       59
   2441  RFYCG        REAL                C         REFS        9       57       59
   2442  RFZCG        REAL                C         REFS       10       57       58
   2615  RLCG         REAL                C         REFS       38    DEFINED     78
   2614  RLCGO        REAL                C         REFS       23       78
   3717  T            REAL                C         REFS       26       50       81
      0  THA          REAL       ARRAY    THARG     REFS        5       50
      0  THF          REAL       ARRAY    THFUN     REFS        5       50
   2600  UDWP         REAL                C         REFS       33       72       73       75       76
                                                 DEFINED       70
   2732  UIMP         REAL                C         REFS       46       70
   2727  UIMPO        REAL                C         REFS       45    DEFINED     69
    115  USINA        REAL                          REFS       55       56    DEFINED     53
    114  XF         * REAL                          REFS       50

 FILE NAMES          MODE
        TAPE6        FMT                   WRITES       81
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EXTERNALS            TYPE   ARGS         REFERENCES
      COSD          REAL     1              54          56
      SIND          REAL     1              53          55
      TABLE                  7              50

STATEMENT LABELS                  DEF LINE     REFERENCES
    0  10           INACTIVE        53            52
   33  20                           61           2*52
   37  30                           67            60
  105  103       FMT                82            81

COMMON BLOCKS    LENGTH      MEMBERS - BIAS NAME(LENGTH)
      C           3830                 0 C       (3830)
      NTH            2                 0 NTH     (2)
      THARG         20                 0 THA     (20)
      THFUN         20                 0 THF     (20)

EQUIV CLASSES    LENGTH      MEMBERS - BIAS NAME(LENGTH)
 C    C           3830           1307 ROELCG  (1)        1312 RFXCG   (1)        1313 RFYCG   (1)
                                 1314 RFZCG   (1)        1319 FMXTH   (1)        1320 FMYTH   (1)
                                 1321 FMZTH   (1)        1400 BALPHT  (1)        1401 BPHIT   (1)
                                 1402 QNALGN  (1)        1403 PCFTH   (1)        1404 QBURN   (1)
                                 1408 UDWP    (1)        1409 FTHRST  (1)        1410 FTHX    (1)
                                 1411 FTHY    (1)        1412 FTHZ    (1)        1413 CISP    (1)
                                 1414 DWT     (1)        1415 DWP     (1)        1416 ROCGD   (1)
                                 1417 ROCG    (1)        1418 FMIXE   (1)        1419 FMIYE   (1)
                                 1420 RLCGO   (1)        1421 RLCG    (1)        1435 UIMPD   (1)
                                 1498 UIMP    (1)        1527 DMASS   (1)        1747 FMIX    (1)
                                 1748 FMIY    (1)        1749 FMIZ    (1)        1939 T       (1)

STATISTICS
  PROGRAM LENGTH                1208       60
  CM LABELED COMMON LENGTH     7440B     3872
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      SUBROUTINE A2                                                     A2       2
C**AERO FORCE AND MOMENT MODULE   BODY AXES                             A2       3
      COMMON /C/ C(3830)                                                A2       4
  101 FORMAT(1H0,4X,21HFRONT LUG CLEARS RAIL,5X,3HT =,1PE10.2,5X,       A2       5
     *        9HREL VEL =,1PE10.2,5X,14HPITCH MOMENT =,1PE10.2)         A2       6
C                                                                       A2       7
C**INPUT DATA                                                           A2       8
      EQUIVALENCE (C(1306),RFAREA)                                      A2       9
      EQUIVALENCE (C(1307),RFLGTH)                                      A2      10
      EQUIVALENCE (C(1316),RLUG  )                                      A2      11
      EQUIVALENCE (C(1317),RAIL  )                                      A2      12
      EQUIVALENCE (C(1742),    AMP2),  (C(1746),    AMP1)               A2      13
      EQUIVALENCE (C(1332),CPHAS )                                      A2      14
      EQUIVALENCE (C(1405),QBURN )                                      A2      15
      EQUIVALENCE (C(1627),AGRAV )                                      A2      16
C                                                                       A2      17
C**INPUTS FROM OTHER MODULES                                            A2      18
      DIMENSION ISNDX(40)                                               A2      19
      EQUIVALENCE (C(3634),   ISNDX),  (C(3512),  I3512)                A2      20
      EQUIVALENCE (C(0203),PDYNMC)                                      A2      21
      EQUIVALENCE (C( 204),VMACH )                                      A2      22
      EQUIVALENCE (C(0207),VAIRSP)                                      A2      23
      EQUIVALENCE (C( 350),BTHT  )                                      A2      24
      EQUIVALENCE (C( 380),RANGO )                                      A2      25
      EQUIVALENCE (C(1203),CX     )                                     A2      26
      EQUIVALENCE (C(1204),CY     )                                     A2      27
      EQUIVALENCE (C(1205),CZ     )                                     A2      28
      EQUIVALENCE (C(1206),CLP    )                                     A2      29
      EQUIVALENCE (C(1207),CMQ    )                                     A2      30
      EQUIVALENCE (C(1208),CNR    )                                     A2      31
      EQUIVALENCE (C(1209),CL     )                                     A2      32
      EQUIVALENCE (C(1210),CM     )                                     A2      33
      EQUIVALENCE (C(1211),CN     )                                     A2      34
      EQUIVALENCE (C(1320),FMXTH )                                      A2      35
      EQUIVALENCE (C(1321),FMYTH )                                      A2      36
      EQUIVALENCE (C(1322),FMZTH )                                      A2      37
      EQUIVALENCE (C(1411),FTHX  )                                      A2      38
      EQUIVALENCE (C(1412),FTHY  )                                      A2      39
      EQUIVALENCE (C(1413),FTHZ  )                                      A2      40
      EQUIVALENCE (C(1422),RLCG  )                                      A2      41
      EQUIVALENCE (C(1723),CFA23 )                                      A2      42
      EQUIVALENCE (C(1735),CFA33 )                                      A2      43
      EQUIVALENCE (C(1739),WP    )                                      A2      44
      EQUIVALENCE (C(1743),WQ    )                                      A2      45
      EQUIVALENCE (C(1737),     FMX),  (C(1741),     FMY), (C(1745), FMZ)  A2   46
      EQUIVALENCE (C(1747),WR    )                                      A2      47
      EQUIVALENCE (C(1748),    FMIX)                                    A2      48
      EQUIVALENCE (C(1738),    WPTD)                                    A2      49
      EQUIVALENCE (C(1751),    GRAD)                                    A2      50
      EQUIVALENCE (C( 626),     VI3)                                    A2      51
      EQUIVALENCE (C(2000),T     )                                      A2      52
      EQUIVALENCE  (C(1972),RKUTTA)                                     A2      53
      EQUIVALENCE (C(1975),NPT)                                         A2      54
C                                                                       A2      55
C**OUTPUTS                                                              A2      56
      EQUIVALENCE (C(1300),FXBA  )                                      A2      57
      EQUIVALENCE (C(1301),FYBA  )                                      A2      58
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      EQUIVALENCE (C(1302),FZBA  )
      EQUIVALENCE (C(1303),FMXBA )
      EQUIVALENCE (C(1304),FMYBA )
      EQUIVALENCE (C(1305),FMZBA )
      EQUIVALENCE (C(1308),RDELCG)
      EQUIVALENCE (C(1628),DMASS )
      EQUIVALENCE (C(1748),FMIX  )
      EQUIVALENCE (C(1749),FMIY  )
      EQUIVALENCE (C(1750),FMIZ  )
C
C**OTHER OUTPUTS
      EQUIVALENCE (C(1323),FMXLUG)
      EQUIVALENCE (C(1324),FMYLUG)
      EQUIVALENCE (C(1325),FMZLUG)
      EQUIVALENCE (C(3504),OPTN4)
C
C**FORCE VECTOR COMPONENTS
      UQS = PDYNMC*RFAREA
      UQSL = UQS*RFLGTH
C
      FXBA=UQS*(-CX)+FTHX
      FYBA=UQS*CY+FTHY
      FZBA=UQS*CZ+FTHZ
C
C** AERO MOMENTS    (NOTE FACTOR OF 2.0 IN DAMPING COEFFICIENT)
      UL2V = 0.
      IF (VAIRSP .GT. 0.) UL2V = RFLGTH/(2.*VAIRSP)
      FMXBA = (CL + CLP*UL2V*WP) * UQSL                   + FMXTH
      FMYBA = (CM + CMQ*UL2V*WQ) * UQSL + FZBA*RDELCG + FMYTH
      FMZBA = (CN + CNR*UL2V*WR) * UQSL - FYBA*RDELCG + FMZTH
C
C
C**MOMENTS AND FORCES DUE TO LUGS
      IF ( (OPTN4 .GT. 0.).AND.(RANGO .LE. RAIL+RLUG) ) GO TO 70
      UFZL2=FZLUG
      FYLUG = 0.
      FZLUG = 0.
      FMXLUG = 0.
      FMYLUG = 0.
      FMZLUG = 0.
      IF (FLG2 .GT.0.) GO TO 74
      FMX=0.      $      FMY=0.      $      FMZ=0.
      DO 6 I=1,13512
      IDO=I
      IF(ISNDX(I).EQ.1743)CALL MCARLC(DUM,1,IDO)
      IF(ISNDX(I).EQ.1747)CALL MCARLO(DUM,1,IDO)
    6 CONTINUE
      C(13) = 1.
      WRITE(6,104)WP,WQ,WR
  104 FORMAT(1H ,50X,*TIPOFF RATES--ROLL = *F6.1,* PITCH = *F6.1,
     .  * YAW = *F6.1)
      FLG2 = 1.
      WRITE(6,102) T,VAIRSP,UFZL2
      WRITE(6,103) RANGO
  103 FORMAT(32X,9HRANGO  = ,F6.4)
  102 FORMAT (1H0,36H        REAR LUG CLEARS RAIL    T = ,F8.4,
     *  10HREL VEL = ,F8.3,16H   RAIL FORCE = ,F8.2)
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      GO TO 74
   70 IF (RANGO .LE. RAIL) GO TO 72
      RZDD=0.
      FYLUG = -(FYBA + DMASS*AGRAV*CFA23 +  FMZBA*
     *        RLCG*DMASS/FMIZ)/(1. + DMASS*RLCG*RLCG/FMIZ)
      FZLUG = -(FZBA + DMASS*AGRAV*(CFA33-RZDD) +  FMYBA*
     *        RLCG*DMASS/FMIY)/(1. + DMASS*RLCG*RLCG/FMIY)
      FMXLUG = - FMXBA
      FMYLUG = FZLUG*RLCG
      FMZLUG = FYLUG*RLCG
      IF (FLG1 .GT. 0.) GO TO 74
      FLG1 = 1.
      WRITE(6, 101) T, VAIRSP, FMYLUG
      WRITE(6,103) RANGO
C
C
C
C
C
C                  WPTO--MONTE CARLO VALUE OF TIPOFF ROLL RATE
C                  DTLUG---TIME INCREMENT BETWEEN FIRST LUG AN)
C                             LAST LUG DROP OFF TIME(TIPOFF ROLL RATE
C                             OCCURS AT LAST LUG)
C                  FMX---ROLL MOMENT THAT GENERATES  TIPOFF ROLL RATE
      DTLUG=.026
      FMX=WPTO*FMIX/CRAD/DTLUG
    5 CONTINUE
C
C
C
C
      GO TO 74
   72 CONTINUE
      RZDD=0.
      FYLUG = -(FYBA + DMASS*AGRAV*CFA23)
      FZLUG = -(FZBA + DMASS*AGRAV*(CFA33-RZDD))
      FMXLUG = - FMXBA
      FMYLUG = - FMYBA
      FMZLUG = - FMZBA
      FLG1 = 0.
      FLG2=0.
   74 CONTINUE
C**TOTAL FORCE AND MOMENTS
      FYBA = FYBA + FYLUG
      FZBA = FZBA + FZLUG
      FMXBA = FMXBA + FMXLUG
      FMYBA = FMYBA + FMYLUG
      FMZBA = FMZBA + FMZLUG
C
C**LAUNCH TRANSIENTS MOMENTS (1-YAW,2-PITCH,3-ROLL MOMENTS)
C
      IF(FLG2.GT.0.)GO TO 75
      IF(VIB.LE.0.)GO TO 75
      CALL LTRAN(T,DELT,AMP2,FMY,WQ0,1,2)
      CALL LTRAN(T,DELT,AMP1,FMZ,WR0,1,1)
   75 CONTINUE
      FMXBA=FMXBA+FMX
```

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      SUBROUTINE A2          74/74    OPT=1                    FTN 4.2+74355      07/07/76  11.06.01.        PAGE    4

                  FMYBA=FMYBA+FMY                                                  A2        173
                  FMZBA=FMZBA+FMZ                                                  A2        174
            C                                                                      A2        175
      175         RETURN                                                           A2        176
                  END                                                              A2        177
```

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     SUBROUTINE A2          74/74    OPT=1                    FTN 4.2+74355        07/07/75  11.06.01.        PAGE     5

        SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS        DEF LINE      REFERENCES
    1  A2                1          175

VARIABLES        SN  TYPE              RELOCATION
  3132  AGRAV         REAL                  C        REFS      15     118      120     149     150
  3321  AMP1          REAL                  C        REFS      12     169
  3315  AMP2          REAL                  C        REFS      12     169
   535  BTHT          REAL                  C        REFS      23
     0  C             REAL       ARRAY      C        REFS       3       8        9      10      11    2*12     13
                                                          14      15    2*19       20      21      22      23     24
                                                          25      26      27       28      29      30      31     32
                                                          33      34      35       36      37      38      39     40
                                                          41      42      43       44    3*45      46      47     48
                                                          49      50      51       52      53      56      57     58
                                                          59      60      61       62      63      64      65     66
                                                          69      70      71       72   DEFINED   105
  3272  CF423         REAL                  C        REFS      41     118      149
  3306  CF433         REAL                  C        REFS      42     120      150
  2270  CL            REAL                  C        REFS      31      85
  2265  CLP           REAL                  C        REFS      28      85
  2271  CM            REAL                  C        REFS      32      85
  2266  CMQ           REAL                  C        REFS      29      86
  2272  CN            REAL                  C        REFS      33      87
  2267  CNR           REAL                  C        REFS      30      87
  2463  CPMAS         REAL                  C        REFS      13
  3326  CRAD          REAL                  C        REFS      49     140
  2262  CX            REAL                  C        REFS      25      78
  2263  CY            REAL                  C        REFS      26      78
  2264  CZ            REAL                  C        REFS      27      80
   353  DELT          REAL                           REFS     168     163
  3133  DMASS         REAL                  C        REFS      63    3*118    3*120    149     150
   352  DTLUG         REAL                           REFS     140   DEFINED    139
   347  DUM           REAL                           REFS     102     103
   351  FLG1          REAL                           REFS     125   DEFINED    126     154
   344  FLG2          REAL                           REFS      90     165    DEFINED   109     155
  3323  FMIX          REAL                  C        REFS      47      64      140
  3324  FMIY          REAL                  C        REFS      65    2*120
  3325  FMIZ          REAL                  C        REFS      66    2*118
  3310  FMX           REAL                  C        REFS      45     171    DEFINED    99     140
  2426  FMXBA         REAL                  C        REFS      59     122      151     160     171
                                                   DEFINED     85     160      171
  2452  FMXLUG        REAL                  C        REFS      69     160    DEFINED    95     122     151
  2447  FMXTH         REAL                  C        REFS      34      85
  3314  FMY           REAL                  C        REFS      45     163      172   DEFINED    99
  2427  FMYBA         REAL                  C        REFS      60     120      152     161     172
                                                   DEFINED     86     161      172
  2453  FMYLUG        REAL                  C        REFS      70     127      161   DEFINED    96     123     152
  2450  FMYTH         REAL                  C        REFS      35      85
  3320  FMZ           REAL                  C        REFS      45     169      173   DEFINED    99
  2430  FMZBA         REAL                  C        REFS      61     118      153     162     173
                                                   DEFINED     87     162      173
  2454  FMZLUG        REAL                  C        REFS      71     162    DEFINED    97     124     153
  2451  FMZTH         REAL                  C        REFS      36      87
  2602  FT4X          REAL                  C        REFS      37      78
  2603  FT4Y          REAL                  C        REFS      38      79
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      SUBROUTINE A2          74/74    OPT=1                              FTN 4.2+74355        07/07/76  11.06.01.     PAGE     6

VARIABLES        SN  TYPE              RELOCATION
  2604  FT4Z         REAL                   C              REFS        39       80
  2423  FX3A         REAL                   C              REFS        56   DEFINED      78
  2424  FY3A         REAL                   C              REFS        57       87       118       149       158
                                                       DEFINED         79      153
   343  FYLUG        REAL                                  REFS       124      158   DEFINED        93       118      149
  2425  FZ3A         REAL                   C              REFS        58       85       120       158       159
                                                       DEFINED         80      159
   342  FZLUG        REAL                                  REFS        92      123       159   DEFINED        94       120      150
   345  I            INTEGER                               REFS       101      102       103   DEFINED       100
   346  IDD          INTEGER                               REFS       102      103   DEFINED       101
  7061  ISNDX        INTEGER        ARRAY   C              REFS        18       19       102       103
  3667  IS512        INTEGER                C              REFS        19      100
  3666  NPT          INTEGER                C              REFS        53
  3657  OPTN4        REAL                   C              REFS        72       91
   312  POYNMC       REAL                   C              REFS        20       75
  2574  QBJRN        REAL                   C              REFS        14
  2444  RAIL         REAL                   C              REFS        11       91       116
   573  RANGO        REAL                   C              REFS        24       91       111       116       128
  2433  RDELCG       REAL                   C              REFS        62       85        87
  2431  RFAREA       REAL                   C              REFS         8       73
  2432  RFLGTH       REAL                   C              REFS         9       75        84
  3663  RKJTTA       REAL                   C              REFS        52
  2615  RLCG         REAL                   C              REFS        40    3*118     3*120       123       124
  2443  RLJG         REAL                   C              REFS        10       91
   350  RZ30         REAL                                  REFS       120      150   DEFINED       117       148
  3717  T            REAL                   C              REFS        51      110       127       168       169
   341  UFZL2        REAL                                  REFS       110   DEFINED       92
   340  UL2V         REAL                                  REFS        85       85        87   DEFINED        83       84
   336  UQS          REAL                                  REFS        76       73        79        88   DEFINED      75
   337  UQSL         REAL                                  REFS        85       85        87   DEFINED        76
   316  VAIRSP       REAL                   C              REFS        22     2*94       110       127
  1161  VIB          REAL                   C              REFS        50      167
   313  VMACH        REAL                   C              REFS        21
  3312  WP           REAL                   C              REFS        43       85       106
  3311  WPTO         REAL                   C              REFS        48      140
  3316  WQ           REAL                   C              REFS        44       85       106
   354  WQ0        * REAL                                  REFS       168
  3322  WR           REAL                   C              REFS        46       87       106
   355  WR0        * REAL                                  REFS       169

FILE NAMES           MODE
        TAPE6        FMT                        WRITES       106       110      111       127       128

EXTERNALS              TYPE   ARGS        REFERENCES
        LTRAN                   7            158       169
        MCARLO                  3            102       103

STATEMENT LABELS                 DEF LINE   REFERENCES
     0  5            INACTIVE       141
     0  6                           104       100
   103  70                          116        91
   146  72                          147       116
   164  74                          156        98       115       125       146
   204  75                          170       166       167
   236  101         FMT               4       127
   305  102         FMT             113       110
   302  103         FMT             112       111       128
```

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STATEMENT LABELS              DEF LINE   REFERENCES
  257  104      FMT              107        106

LOOPS  LABEL    INDEX       FROM-TO     LENGTH      PROPERTIES
   56  0        * I         100 104      14B                      EXT REFS

COMMON BLOCKS     LENGTH      MEMBERS - BIAS NAME(LENGTH)
   C               3830                   0 C      (3830)

EQUIV CLASSES     LENGTH      MEMBERS - BIAS NAME(LENGTH)
C       C          3830              202 PDYNMC  (1)        203 VMACH   (1)         236 VAIRSP  (1)
                                     349 BTHT    (1)        379 RANGO   (1)         625 VIB     (1)
                                    1202 CX      (1)       1203 CY      (1)        1204 CZ      (1)
                                    1205 CLP     (1)       1206 CMQ     (1)        1207 CNR     (1)
                                    1208 CL      (1)       1209 CM      (1)        1210 CN      (1)
                                    1299 FXBA    (1)       1300 FYBA    (1)        1301 FZBA    (1)
                                    1302 FMXBA   (1)       1303 FMYBA   (1)        1304 FMZBA   (1)
                                    1305 RFAREA  (1)       1306 RFLGTH  (1)        1307 RDELCG  (1)
                                    1315 RLUG    (1)       1316 RAIL    (1)        1319 FMXTN   (1)
                                    1320 FMYTN   (1)       1321 FMZTN   (1)        1322 FMXLUG  (1)
                                    1323 FMYLUG  (1)       1324 FMZLUG  (1)        1331 CPHAS   (1)
                                    1404 QBURN   (1)       1410 FTHX    (1)        1411 FTHY    (1)
                                    1412 FTHZ    (1)       1421 RLCG    (1)        1626 AGRAV   (1)
                                    1627 DMASS   (1)       1722 CFA23   (1)        1734 CFA38   (1)
                                    1736 FMX     (1)       1737 WPTO    (1)        1738 WP      (1)
                                    1740 FMY     (1)       1741 AMP2    (1)        1742 WQ      (1)
                                    1744 FMZ     (1)       1745 AMP1    (1)        1746 WR      (1)
                                    1747 FMIX    (1)       1748 FMIY    (1)        1749 FMIZ    (1)
                                    1750 CRAD    (1)       1971 RKUTTA  (1)        1974 NPT     (1)
                                    1999 T       (1)       3503 OPTN4   (1)        3511 I3512   (1)
                                    3633 ISNDX   (40)

STATISTICS
  PROGRAM LENGTH                 3560B     238
  CM LABELED COMMON LENGTH      7366B     3830
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      SUBROUTINE LTRAN(T,DE,T,AMP,Y,YC,IFLG,K)                   A2     178
      DIMENSION A(5,3),PHI(5,3),W(5,3)                           A2     179
      DATA IMAX,AE/4,-1./                                        A2     180
      DATA (A(I,1),I=1,5)/1.,4.,12.,26.,0./                      A2     181
      DATA (A(I,2),I=1,5)/1.,4.,12.,26.,0./                      A2     182
      DATA (A(I,3),I=1,5)/1.,4.,12.,26.,0./                      A2     183
      IF(IFLG.GT.0)GO TO 17                                      A2     184
      ZC=0.                                                      A2     185
      W1=5.2d*11.                                                A2     186
      DO 1 I=1,IMAX                                              A2     187
      CALL RANNUM(0.,RNSTRT,RN)                                  A2     188
      PHI(I,K)=3.14*RN                                           A2     189
      W(I,K)=I*W1                                                A2     190
C ZC IS INTEGRATION CONSTANT FOR Z                               A2     191
      B=W(I,K)*T+PHI(I,K)                                        A2     192
      ZC=ZC+ A(I,K)*(AE*SIN(B)-W(I,K)*COS(B))/(AE**2+W(I,K)**2)  A2     193
    1 CONTINUE                                                   A2     194
      YC=AMP*EXP(AE*T)*ZC                                        A2     195
   17 CONTINUE                                                   A2     196
      Z=0.                                                       A2     197
      DO 2 I=1,IMAX                                              A2     198
      Z=Z+A(I,K)*SIN(W(I,K)*T+PHI(I,K))                          A2     199
    2 CONTINUE                                                   A2     200
      Y=AMP*EXP(AE*T)*Z                                          A2     201
      RETURN                                                     A2     202
      END                                                        A2     203
```

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SUBROUTINE LTRAN       74/74    OPT=1                           FTN 4.2+74355        07/07/75  11.06.05.       PAGE    2

      SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS       DEF LINE      REFERENCES
   3  LTRAN            1            25

VARIABLES        SN  TYPE               RELOCATION
   116  A            REAL          ARRAY                REFS          2        15         22    DEFINED       4        5        6
   101  AE           REAL                               REFS       2*15        13         24    DEFINED       3
     0  AMP          REAL                    F.P.       REFS         10        24    DEFINED          1
   114  B            REAL                               REFS       2*16   DEFINED         15
     0  DELT         REAL         *UNUSED    F.P.    DEFINED          1
   111  I            INTEGER                            REFS         12      2*13       2*15       3*16     3*22
                                                     DEFINED         10        21
     0  IFLG         INTEGER                 F.P.       REFS          7   DEFINED          1
   100  IMAX         INTEGER                            REFS         10        21    DEFINED          3
     0  K            INTEGER                 F.P.       REFS         12        13       2*15       3*15     3*22
                                                     DEFINED          1
   135  PHI          REAL          ARRAY                REFS          2        15         22    DEFINED      12
   113  RN           REAL                               REFS         11        12
   112  RNSTRT     * REAL                               REFS         11
     0  T            REAL                    F.P.       REFS         15        18         22         24    DEFINED      1
   154  W            REAL          ARRAY                REFS          2        15       2*16         22    DEFINED     13
   110  X1           REAL                               REFS         13   DEFINED          9
     0  Y            REAL                    F.P.    DEFINED          1        24
     0  YC           REAL                    F.P.    DEFINED          1        19
   115  Z            REAL                               REFS         22        24    DEFINED         20       22
   107  ZC           REAL                               REFS         16        18    DEFINED          8       16

EXTERNALS          TYPE    ARGS          REFERENCES
      COS          REAL      1 LIBRARY       16
      EXP          REAL      1 LIBRARY       18        24
      RANNUM                 3               11
      SIN          REAL      1 LIBRARY       15        22

STATEMENT LABELS                 DEF LINE    REFERENCES
     0  1                           17          10
     0  2                           23          21
    47  17                          19           7

LOOPS   LABEL     INDEX      FROM-TO     LENGTH      PROPERTIES
   12   1        * I          10 17        30B                 EXT REFS
   51   2        * I          21 23        153                 EXT REFS

STATISTICS
  PROGRAM LENGTH                1730       123
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      SUBROUTINE D1I                                                   D1        2
C**   TRANSLATIONAL DYNAMICS INITIALIZATION MODULE FOR D1              D1        3
      COMMON /C/ C(3838)                                               LABC04   14
      EQUIVALENCE (C(2561),N     )                                     D1        5
      EQUIVALENCE (C(2562),IPL   )                                     D1        6
      DIMENSION IPL(100), ISNDX(40), ITNDX(10)                         D1        7
      EQUIVALENCE (C(3634), ISNDX), (C(3512), I3512)                   D1        8
C                                                                      D1        9
C** INPUT DATA                                                         D1       10
      EQUIVALENCE (C( 100),VWXE  )                                     D1       11
      EQUIVALENCE (C( 101),VWYE  )                                     D1       12
      EQUIVALENCE (C( 102),VWZE  )                                     D1       13
      EQUIVALENCE (C( 204),VMACH )                                     D1       14
      EQUIVALENCE (C( 367),BALPHA)                                     D1       15
      EQUIVALENCE (C( 368),BALPHY)                                     D1       16
      EQUIVALENCE (C( 427),BTHTG )                                     D1       17
      EQUIVALENCE (C( 431),BPSIG )                                     D1       18
      EQUIVALENCE (C(1539),DPTARG)                                     D1       19
      EQUIVALENCE (C(1666),BLOSV )                                     D1       20
      EQUIVALENCE (C(1667),RSLANT)                                     D1       21
      EQUIVALENCE (C(1674),VMWTE )                                     D1       22
      EQUIVALENCE (C(1751),CRAD  )                                     D1       23
      EQUIVALENCE (C(3502),OPTN2 )                                     D1       24
      EQUIVALENCE (C(3504),OPTN4 )                                     D1       25
      EQUIVALENCE (C(3506),OPTN6 )                                     D1       26
C                                                                      D1       27
C** OUTPUT TO MODULES                                                  D1       28
      EQUIVALENCE (C(1615),RXE   )                                     D1       29
      EQUIVALENCE (C(1619),RYE   )                                     D1       30
      EQUIVALENCE (C(1623),RZE   )                                     D1       31
      EQUIVALENCE (C(1603),VXE   )                                     D1       32
      EQUIVALENCE (C(1607),VYE   )                                     D1       33
      EQUIVALENCE (C(1611),VZE   )                                     D1       34
      EQUIVALENCE (C(1651),RTXE  )                                     D1       35
      EQUIVALENCE (C(1655),RTYE  )                                     D1       36
      EQUIVALENCE (C(1659),RTZE  )                                     D1       37
      EQUIVALENCE (C(1668),RXO   )                                     D1       38
      EQUIVALENCE (C(1669),RYO   )                                     D1       39
      EQUIVALENCE (C(1670),RZO   )                                     D1       40
      EQUIVALENCE (C(1671),VXO   )                                     D1       41
      EQUIVALENCE (C(1672),VYO   )                                     D1       42
      EQUIVALENCE (C(1673),VZO   )                                     D1       43
      EQUIVALENCE (C(1752),BPHIO )                                     D1       44
      EQUIVALENCE (C(1753),BTHTO )                                     D1       45
      EQUIVALENCE (C(1754),BPSIO )                                     D1       46
      EQUIVALENCE (C(1665),RMZRO  )                                    D1       47
      EQUIVALENCE (C(1635), RDELX)                                     D1       48
      EQUIVALENCE (C(1636), RDELY)                                     D1       49
      EQUIVALENCE (C(1637), RDELZ)                                     D1       50
      EQUIVALENCE (C(1680),RSJYMC)                                     D1       51
      EQUIVALENCE (C(1681),RSJZMC)                                     D1       52
      EQUIVALENCE (C(3753),ITNDX), (C(3721),ITCT)                      D1       53
      EQUIVALENCE (C(1761),  A011)                                     D1       54
      EQUIVALENCE (C(1762),  A012)                                     D1       55
      EQUIVALENCE (C(1763),  A013)                                     D1       56
      EQUIVALENCE (C(1755),  A021)                                     D1       57
      EQUIVALENCE (C(1756),  A022)                                     D1       58
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          EQUIVALENCE (C(1757),   A023)                             D1         59
          EQUIVALENCE (C(1758),   A031)                             D1         60
          EQUIVALENCE (C(1759),   A032)                             D1         61
          EQUIVALENCE (C(1760),   A033)                             D1         62
          EQUIVALENCE (C(1764),     P1)                             D1         63
          EQUIVALENCE (C(1765),R1)                                  ROLLGYRO   14
          EQUIVALENCE (C(1768),   XB01)                             D1         67
          EQUIVALENCE (C(1769),   YB01)                             D1         68
          EQUIVALENCE (C(1770),   ZB01)                             D1         69
          EQUIVALENCE (C(1771),   XB02)                             D1         70
          EQUIVALENCE (C(1772),   YB02)                             D1         71
          EQUIVALENCE (C(1773),   ZB02)                             D1         72
          EQUIVALENCE (C( 360),BPH1ER)                              D1         73
          EQUIVALENCE (C( 361),BTH2ER)                              D1         74
          EQUIVALENCE (C( 362),BPS1ER)                              D1         75
          EQUIVALENCE (C(1562),GSPOTY)                              D1         76
          EQUIVALENCE (C(1572),GSPOTZ)                              D1         77
          EQUIVALENCE (C(1581),SIGSPOT)                             D1         78
          EQUIVALENCE (C(1579),   ZETA)                             D1         79
          EQUIVALENCE (C(1580),     W0)                             D1         80
C                                                                   D1         81
C                                                                   D1         82
C* ZERO OUT SPOT JITTER MAX/MIN STORAGE LOCATIONS THAT ARE SAVED IN OUTP D1     83
          C(1567) = 0.                                              D1         84
          C(1568) = 0.                                              D1         85
          C(1577) = 0.                                              D1         86
          C(1578) = 0.                                              D1         87
C  PRINTED FROM MODULE G4                                           D1         88
          W0 = 3.94                                                 D1         89
          ZETA = .745                                               D1         90
C                                                                   D1         91
C SPOT JITTER MONTE CARLO INITIAL VALUES                            D1         92
C                                                                   D1         93
          RSJYMC = 0.                                               D1         94
          RSJZMC = 0.                                               D1         95
          DO 500 IOL=1,ITCT                                         D1         96
          ITSNDX = IOL                                              D1         97
          IF(ITNDX(IOL).NE.1680) GO TO 502                          D1         98
          IPL(N)=1560                                               D1         99
          IPL(N+1)=1563                                             D1        100
          N=N+2                                                     D1        101
          IF(SIGSPOT.NE.0.)                                         D1        102
        1 GSPOTY = .707*SIGSPOT/SQRT(W0/4./ZETA * C(2664))          D1        103
          CALL MCARLO(RNSTRT,4,ITSNDX)                              D1        104
      502 IF(ITNDX(IOL).NE.1681) GO TO 500                          D1        105
          IPL(N)=1570                                               D1        106
          IPL(N+1)=1573                                             D1        107
          N=N+2                                                     D1        108
          IF(SIGSPOT.NE.0.)                                         D1        109
        1 GSPOTZ = .707*SIGSPOT/SQRT(W0/4./ZETA * C(2664))          D1        110
          CALL MCARLO(RNSTRT,4,ITSNDX)                              D1        111
      500 CONTINUE                                                  D1        112
C                                                                   D1        113
          IPL(N) = 1600                                             D1        114
          IPL(N+1) = 1604                                           D1        115
          IPL(N+2) = 1608                                           D1        116
          IPL(N+3) = 1612                                           D1        117
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          IPL(N+4) = 1616                                          01       118
          IPL(N+5) = 1620                                          01       119
          IPL(N+6) = 1640                                          01       120
          IPL(N+7) = 1644                                          01       121
          IPL(N+8) = 1648                                          01       122
          IPL(N+9) = 1652                                          01       123
          IPL(N+10) = 1656                                         01       124
          N = N+11                                                 01       125
          C( 363) = 0.                                             01       126
          C( 364) = 0.                                             01       127
          CRAD = 57.295778                                         01       128
C                                                                  01       129
          IF (OPTN2.LE.0.) RETURN                                  01       130
          IF (OPTARG .LE. 0.) N = N-5                              01       131
C                                                                  01       132
C**CALCULATE MISSILE PARAMETER INITIAL CONDITIONS                   01       133
          RYE=0.                                                   01       134
          RTZE = 0.                                                01       135
          RTYE = 0.                                                01       136
          RTXE = 0.                                                01       137
          BPHIO = 0.                                               01       138
          XB01 = 0.                                                01       139
          YB01 = 1.                                                01       140
          ZB01 = 0.                                                01       141
C                                                                  01       145
C***     MONTE CARLO AUTOPILOT GYRO DRIFT RATES                    01       146
          P1 = 0.                                                  01       147
          R1=0.                                                    ROLLGYRO  15
          DO 503 I = 1,I3512                                       01       151
          IDO = I                                                  01       152
          IF(ISNOX(I).EQ.1764) CALL MCARLO (DUM, 1, IDO)           01       153
          IF(ISNOX(I).EQ.1765) CALL MCARLO (DUM, 1, IDO)           01       154
   503 CONTINUE                                                    01       157
C                                                                  01       158
C                                                                  01       159
C*** AUTOPILOT GYRO BIAS ERRORS                                     01       160
C                                                                  01       161
          BPHIER = 0.                                              01       162
          BPSIER = 0.                                              01       164
          DO 11 I = 1, I3512                                       01       165
          IDO = I                                                  01       166
          IF(ISNOX(I).EQ.360) CALL MCARLO (DUM, 1, IDO)            01       167
          IF(ISNOX(I).EQ.362) CALL MCARLO (DUM, 1, IDO)            01       169
    11 CONTINUE                                                    01       170
C                                                                  01       171
C** INITIALIZE MATRIX COEF FOR AUTOPILOT GYRO MODELS                01       172
C                                                                  01       173
          USPHI1 = SIND(BPHIO + BPHIER)                            01       174
          UCPHI1 = COSD(BPHIO + BPHIER)                            01       175
          USTHT2=SIND(BTHTO)                                       ROLLGYRO  16
          UCTHT2=COSD(BTHTO)                                       ROLLGYRO  17
          USPSI1 = SIND(BPSIO + BPSIER)                            01       178
          UCPSI1 = COSD(BPSIO + BPSIER)                            01       179
          A011 = UCPSI1*UCTHT2                                     01       180
          A012 = USPSI1*UCTHT2                                     01       181
          A013 = -USTHT2                                           01       182
          A021 = -USPSI1*UCPHI1 + UCPSI1*USTHT2*USPHI1             01       183
```

```
      A022 = UCPSI1*UCPHI1 + USPSI1*USTHT2*USPHI1
      A023 = UCTHT2*USPHI1
      A031 = UCPSI1*USTHT2*UCPHI1 + USPSI1*USPHI1
      A032 = USPSI1*USTHT2*UCPHI1 - UCPSI1*USPHI1
      A033 = UCTHT2*UCPHI1
C
C
C MISSILE INITIAL ATTITUDE ERRORS
C
      DO 5 I = 1, I3512
      IDO = I
      IF(ISNUX(I).EQ.1752) CALL MCARLO (DUM, 1, IDO)
      IF(ISNUX(I).EQ.1753) CALL MCARLO (DUM, 1, IDO)
      IF(ISNUX(I).EQ.1754) CALL MCARLO (DUM, 1, IDO)
    5 CONTINUE
C
      IF (OPTN2.GT.1.0) GO TO 10
      RXE=-RSLANT*COSD(BLOSV)
      RZE=RSLANT*SIND(BLOSV)
      GO TO 20
   10 RSLANT = SQRT(RZE**2 + RXE**2)
   20 RM = RHZRO - RZE
C
      IF (OPTN4 .GT. 0.) GO TO 30
      BPSIO = CRAD*ASIN(SIND(BPSIG)*RSLANT/RXE)
      CPSIO  = COSD(BPSIO)
      TTHTG  = SIND(BTHTG)/COSD(BTHTG)
      BTHTO = ATAND((-RZE/RXE - TTHTG*CPSIO),(CPSIO - TTHTG*RZE/RXE))
      GO TO 40
   30 CONTINUE
      IF (OPTN4 .GT. 1.) GO TO 40
      UST = SIND(BTHTO)
      USP = SIND(BPSIO)
      UCP = COSD(BPSIO)
      UCT = COSD(BTHTO)
      UCPH = COSD(BPHIO)
      USPH = SIND(BPHIO)
      RXBA = -RXE*UCP*UCT + RZE*UST
      RYBA = -RXE*(UCP*UST*USPH - USP*UCPH) - RZE*UCT*USPH
      RZBA = -RXE*(UCP*UST*UCPH + USP*USPH) - RZE*UCT*UCPH
      BTHTG = ATAND(-RZBA,RXBA)
      BPSIG = ATAND( RYBA,(RXBA*COSD(BTHTG)-RZBA*SIND(BTHTG)))
   40 CONTINUE
C
   24 VSOUND = 1117.3 - .00392*RH
      IF (OPTN6 .LE. 0.) VMWTE = VMACH*VSOUND
      VMWXY = VMWTE*COSD(BALPHA - BTHTO)
C
      VXE = VWXE + VMWXY*COSD(BALPHY + BPSIO)
      VYE = VWYE + VMWXY*SIND(BALPHY + BPSIO)
      VZE = VWZE + VMWTE*SIND(BALPHA - BTHTO)
C
      RXO = RXE
      RYO = RYE
      RZO = RZE
      VXO = VXE
      VYO = VYE
```

```
      VZO = VZE
230   RDELX = RTXE - RXE
      RDELY = RTYE - RYE
      RDELZ = RTZE - RZE
      RETURN
      END
```

CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
96	I	ITCT	THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.
97	I	ITCT	THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.
103	I	ITCT	THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.
104	I	ITCT	THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.

```
      SUBROUTINE DII          74/74    OPT=1                          FTN 4.2+74355        07/07/75  11.06.08.       PAGE      7

           SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS        DEF LINE      REFERENCES
    1  DII                  1         127        233

 VARIABLES          SN  TYPE                RELOCATION
  3340  A011        REAL                       C          REFS          53   DEFINED        168
  3341  A012        REAL                       C          REFS          54   DEFINED        169
  3342  A013        REAL                       C          REFS          55   DEFINED        170
  3332  A021        REAL                       C          REFS          56   DEFINED        171
  3333  A022        REAL                       C          REFS          57   DEFINED        172
  3334  A023        REAL                       C          REFS          58   DEFINED        173
  3335  A031        REAL                       C          REFS          59   DEFINED        174
  3336  A032        REAL                       C          REFS          60   DEFINED        175
  3337  A033        REAL                       C          REFS          61   DEFINED        176
   556  BALPHA      REAL                       C          REFS          14        218        222
   557  BALPHY      REAL                       C          REFS          15        220        221
  3201  BLOSV       REAL                       C          REFS          19        189        190
  3327  BP4IO       REAL                       C          REFS          43        162        163        207        208
                                                        DEFINED        135
   547  BP4IER      REAL                       C          REFS          70        162        163    DEFINED        152
   656  BPSIG       REAL                       C          REFS          17        196    DEFINED        213
  3331  BPSIO       REAL                       C          REFS          45        166        167        197        204        205        220
                                                             221   DEFINED        196
   551  BPSIER      REAL                       C          REFS          72        165        167    DEFINED        153
   652  BTHTG       REAL                       C          REFS          16      2*198      2*213    DEFINED        212
  3330  ETHTO       REAL                       C          REFS          44        164        165        203        206        210        222
                                                        DEFINED        199
   550  BTHZER      REAL                       C          REFS          71
     0  C           REAL            ARRAY      C          REFS           3          4          5        2*7         10         11         12
                                                              13          14         15         16         17         18         19         20
                                                              21          22         23         24         25         28         29         30
                                                              31          32         33         34         35         36         37         38
                                                              39          40         41         42         43         44         45         46
                                                              47          48         49         50         51       2*52         53         54
                                                              55          56         57         58         59         60         61         62
                                                              63          64         65         66         67         68         69         70
                                                              71          72         73         74         75         76         77         99
                                                             106     DEFINED         81         82         83         84        123        124
   513  CPSIO       REAL                                  REFS       2*199    DEFINED        197
  3326  CRAD        REAL                       C          REFS          22        196    DEFINED        125
   503  DUM         REAL                                  REFS         145        146        156        157        183        184        185
  3031  GSPOTY      REAL                       C          REFS          73    DEFINED         99
  3043  GSPOTZ      REAL                       C          REFS          74    DEFINED        106
   501  I           INTEGER                               REFS         144        145        146        155        156        157        182
                                                             183         184        185    DEFINED        143        154        181
   502  IDO         INTEGER                               REFS         145        146        156        157        183        184        185
                                                        DEFINED        144        155        182
   476  IOL         INTEGER                               REFS          94         95        102    DEFINED         93
  5001  IPL         INTEGER         ARRAY      C          REFS           5          6    DEFINED         96         97        103        104
                                                             111         112        113        114        115        116        117        118
                                                             119         120        121
  7061  ISNDX       INTEGER         ARRAY      C          REFS           6          7        145        146        176        157        183
                                                             184         185
  7210  ITOT        INTEGER                    C          REFS          52         93
  7250  ITNDX       INTEGER         ARRAY      C          REFS           6         52         95        102
   477  ITSNDX      INTEGER                               REFS         101        108    DEFINED         94
```

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      SUBROUTINE D1I          74/74    OPT=1                        FTN 4.2+74355       07/07/75  11.06.08.        PAGE     8

 VARIABLES       SN  TYPE              RELOCATION
  3667  I3912        INTEGER             C           REFS         7       143       194       101
  3000  N            INTEGER             C           REFS         4        96        97        98       103       104       105
                                                      111       112       113       114       115       116       117       118
                                                      119       120       121       122       128   DEFINED        98       105
                                                      122       128
  3146  OPTARG       REAL                C           REFS        18       128
  3655  OPTNZ        REAL                C           REFS        23       187       190
  3657  OPTN+        REAL                C           REFS        24       195       232
  3661  OPTNO        REAL                C           REFS        25       217
  3343  PI           REAL                C           REFS        62   DEFINED       141
  3142  RDELX        REAL                C           REFS        47   DEFINED       230
  3143  RDELY        REAL                C           REFS        48   DEFINED       231
  3144  RDELZ        REAL                C           REFS        49   DEFINED       232
   512  RH           REAL                            REFS       216   DEFINED       193
  3200  RHZRO        REAL                C           REFS        46       193
   500  RNSTRT       REAL                            REFS       101       108
  3217  RSJYMC       REAL                C           REFS        50   DEFINED        91
  3220  RSJZMC       REAL                C           REFS        51   DEFINED        92
  3202  RSLANT       REAL                C           REFS        20       189       190       196   DEFINED       192
  3162  RTXE         REAL                C           REFS        34       230   DEFINED       134
  3166  RTYE         REAL                C           REFS        35       231   DEFINED       133
  3172  RTZE         REAL                C           REFS        36       232   DEFINED       132
   523  RX3A         REAL                            REFS       212       213   DEFINED       209
  3116  RXE          REAL                C           REFS        28       192       196     2*199       209       210       211
                                                      224       230   DEFINED       189
  3203  RXD          REAL                C           REFS        37   DEFINED       224
   524  RY3A         REAL                            REFS       213   DEFINED       210
  3122  RYE          REAL                C           REFS        29       225       231   DEFINED       131
  3204  RYD          REAL                C           REFS        30   DEFINED       225
   525  RZ3A         REAL                            REFS       212       213   DEFINED       211
  3126  RZE          REAL                C           REFS        30       192       193     2*199       209       210       211
                                                      226       232   DEFINED       190
  3205  RZD          REAL                C           REFS        39   DEFINED       226
  3344  RI           REAL                C           REFS        63   DEFINED       142
  3054  SIGSPOT      REAL                C           REFS        75     2*199     2*106
   514  TTHTG        REAL                            REFS     2*199   DEFINED       198
   517  UCP          REAL                            REFS       209       210       211   DEFINED       205
   521  UCPH         REAL                            REFS       210     2*211   DEFINED       207
   505  UCPHI1       REAL                            REFS       171       172       174       175       176
                                                  DEFINED       163
   511  UCPSI1       REAL                            REFS       168       171       172       174       175
                                                  DEFINED       167
   520  UCT          REAL                            REFS       209       210       211   DEFINED       206
   507  UCTHT2       REAL                            REFS       168       169       173       176   DEFINED       165
   516  USP          REAL                            REFS       210       211   DEFINED       204
   522  USPH         REAL                            REFS     2*210       211   DEFINED       208
   504  USPHI1       REAL                            REFS       171       172       173       174       175
                                                  DEFINED       162
   510  USPSI1       REAL                            REFS       169       171       172       174       175
                                                  DEFINED       166
   515  UST          REAL                            REFS       209       210       211   DEFINED       203
   506  USTHT2       REAL                            REFS       170       171       172       174       175
                                                  DEFINED       164
   313  VMACH        REAL                C           REFS        13       217
  3211  VMAXZ        REAL                C           REFS        21       218       222   DEFINED       217
   527  VMAXY        REAL                            REFS       220       221   DEFINED       218
   526  VSOUND       REAL                            REFS       217   DEFINED       216
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SUBROUTINE DI1          74/74    OPT=1                          FTN 4.2+74353       07/07/75  11.06.08.       PAGE     9

VARIABLES       SN  TYPE             RELOCATION
   143  VWXE        REAL                 C             REFS          10       220
   144  VWYE        REAL                 C             REFS          11       221
   145  VWZE        REAL                 C             REFS          12       222
  3102  VXE         REAL                 C             REFS          31       227    DEFINED       220
  3206  VXO         REAL                 C             REFS          40   DEFINED        227
  3106  VYE         REAL                 C             REFS          32       228    DEFINED       221
  3207  VYO         REAL                 C             REFS          41   DEFINED        228
  3112  VZE         REAL                 C             REFS          33       229    DEFINED       222
  3210  VZO         REAL                 C             REFS          42   DEFINED        229
  3053  WO          REAL                 C             REFS          77        99        106   DEFINED       96
  3347  XB01        REAL                 C             REFS          64   DEFINED        136
  3352  XB02        REAL                 C             REFS          67
  3350  YB01        REAL                 C             REFS          65   DEFINED        137
  3353  YB02        REAL                 C             REFS          68
  3351  ZB01        REAL                 C             REFS          66   DEFINED        138
  3354  ZB02        REAL                 C             REFS          69
  3052  ZETA        REAL                 C             REFS          76        99        106   DEFINED       87

EXTERNALS           TYPE    ARGS         REFERENCES
        ASIN        REAL     1 LIBRARY      196
        ATAND       REAL     2              199        212       213
        COSD        REAL     1              163        165       167       189       197       198       205       206       207
                                            213        218       220
        MCARLO               3              101        108       145       146       156       157       183       184       185
        SIND        REAL     1              162        164       166       190       196       198       203       204       208
                                            213        221       222
        SQRT        REAL     1 LIBRARY       99        106       192

STATEMENT LABELS              DEF LINE   REFERENCES
     0  5                        186        191
   243  10                       192        188
     0  11                       158        154
   247  20                       193        191
     0  24        INACTIVE       216
   276  30                       201        195
   351  40                       214        200       202
    51  500                      109         93       102
    31  502                      102         95
     0  503                      147        143

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   11  500     * IOL       93 109      438              EXT REFS
  114  503     * I        143 147      148              EXT REFS
  132  11      * I        154 158      148              EXT REFS
  213  5       * I        181 186      208              EXT REFS

COMMON BLOCKS   LENGTH     MEMBERS - BIAS NAME(LENGTH)
       C          3830                0 C      (3830)

EQUIV CLASSES   LENGTH     MEMBERS - BIAS NAME(LENGTH)
C      C          3830           99 VWXE     (1)            100 VWYE    (1)             101 VWZE    (1)
                                203 VMACH    (1)            359 BPH1ER  (1)             360 BTH2ER  (1)
                                361 BPS1ER   (1)            366 BALPHA  (1)             357 BALPWY  (1)
                                426 BTHTG    (1)            430 BPSIG   (1)            1551 GSPOTY  (1)
                               1571 GSPOTZ   (1)           1570 ZETA    (1)            1579 WO      (1)
                               1580 SIGSPOT  (1)           1602 VXE     (1)            1606 VYE     (1)
                               1610 VZE      (1)           1614 RXE     (1)            1618 RYE     (1)
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SUBROUTINE DII          74/74    OPT=1                          FTN 4.2+74355      07/07/75   11.06.08.      PAGE    10

EQUIV CLASSES    LENGTH     MEMBERS - BIAS NAME(LENGTH)
                                 1622 REE      (1)                  1634 RDELX   (1)                1635 RDELY   (1)
                                 1636 RDELZ    (1)                  1638 OPTARG  (1)                1650 RTXE    (1)
                                 1654 RTYE     (1)                  1658 RTZE    (1)                1656 RHZRO   (1)
                                 1665 BLOSV    (1)                  1666 RSLANT  (1)                1667 RXO     (1)
                                 1668 RYO      (1)                  1669 RZO     (1)                1670 VXO     (1)
                                 1671 VYO      (1)                  1672 VZO     (1)                1673 VMNTE   (1)
                                 1679 RSJYNC   (1)                  1680 RSJZNC  (1)                1750 GRAD    (1)
                                 1751 BPHIO    (1)                  1752 BTHTO   (1)                1753 BPSIO   (1)
                                 1754 A021     (1)                  1755 A022    (1)                1756 A023    (1)
                                 1757 A031     (1)                  1758 A032    (1)                1759 A033    (1)
                                 1760 A011     (1)                  1761 A012    (1)                1762 A013    (1)
                                 1763 P1       (1)                  1764 R1      (1)                1767 XB01    (1)
                                 1768 YB01     (1)                  1769 ZB01    (1)                1770 XB02    (1)
                                 1771 YB02     (1)                  1772 ZB02    (1)                2550 N       (1)
                                 2561 IPL      (100)                3501 OPTN2   (1)                3503 OPTN4   (1)
                                 3505 OPTN6    (1)                  3511 I3512   (1)                3633 ISNDX   (40)
                                 3720 ITCT     (1)                  3752 ITNDX   (10)

STATISTICS
  PROGRAM LENGTH                5308      34.
  CM LABELED COMMON LENGTH     73668    3830
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      SUBROUTINE D1                                             D1       247
C**TRANSLATIONAL DYNAMICS MODULE                                D1       248
      COMMON /C/ C(3838)                                        LABC04    15
C                                                               D1       250
C**INPUT DATA                                                   D1       251
      EQUIVALENCE (C(1627),AGRAV )                              D1       252
      EQUIVALENCE (C(1628),BMASS )                              D1       253
      EQUIVALENCE (C(1629),ATHRST)                              D1       254
      EQUIVALENCE (C(1630),ATURNT)                              D1       255
      EQUIVALENCE (C(1531),BGAMT )                              D1       256
      EQUIVALENCE (C(1639),OPTARG)                              D1       257
      EQUIVALENCE (C(1681),ADIVE )                              D1       258
      EQUIVALENCE (C(1791),CRAD  )                              D1       259
C                                                               D1       260
C**INPUTS FROM OTHER MODULES                                    D1       261
      EQUIVALENCE (C(1300),FXBA  )                              D1       262
      EQUIVALENCE (C(1301),FYBA  )                              D1       263
      EQUIVALENCE (C(1302),FZBA  )                              D1       264
      EQUIVALENCE (C(1703),CFA11 )                              D1       265
      EQUIVALENCE (C(1707),CFA12 )                              D1       266
      EQUIVALENCE (C(1711),CFA13 )                              D1       267
      EQUIVALENCE (C(1715),CFA21 )                              D1       268
      EQUIVALENCE (C(1719),CFA22 )                              D1       269
      EQUIVALENCE (C(1723),CFA23 )                              D1       270
      EQUIVALENCE (C(1727),CFA31 )                              D1       271
      EQUIVALENCE (C(1731),CFA32 )                              D1       272
      EQUIVALENCE (C(1735),CFA33 )                              D1       273
      EQUIVALENCE (C(2000),T     )                              D1       274
C                                                               D1       275
C**STATE VARIABLE OUTPUTS                                       D1       276
      EQUIVALENCE (C(1600),VXED  )                              D1       277
      EQUIVALENCE (C(1603),VXE   )                              D1       278
      EQUIVALENCE (C(1604),VYED  )                              D1       279
      EQUIVALENCE (C(1607),VYE   )                              D1       280
      EQUIVALENCE (C(1608),VZED  )                              D1       281
      EQUIVALENCE (C(1611),VZE   )                              D1       282
      EQUIVALENCE (C(1612),RXED  )                              D1       283
      EQUIVALENCE (C(1615),RXE   )                              D1       284
      EQUIVALENCE (C(1616),RYED  )                              D1       285
      EQUIVALENCE (C(1519),RYE   )                              D1       286
      EQUIVALENCE (C(1520),RZED  )                              D1       287
      EQUIVALENCE (C(1523),RZE   )                              D1       288
      EQUIVALENCE (C(1540),VTARGD)                              D1       289
      EQUIVALENCE (C(1543),VTARG )                              D1       290
      EQUIVALENCE (C(1644),BPSITD)                              D1       291
      EQUIVALENCE (C(1647),BPSIT )                              D1       292
      EQUIVALENCE (C(1648),RTXED )                              D1       293
      EQUIVALENCE (C(1551),RTXE  )                              D1       294
      EQUIVALENCE (C(1552),RTYED )                              D1       295
      EQUIVALENCE (C(1655),RTYE  )                              D1       296
      EQUIVALENCE (C(1656),RTZED )                              D1       297
      EQUIVALENCE (C(1659),RTZE  )                              D1       298
C                                                               D1       299
C**OTHER OUTPUTS                                                D1       300
      EQUIVALENCE (C(1624),AXBA  )                              D1       301
      EQUIVALENCE (C(1625),AYBA  )                              D1       302
      EQUIVALENCE (C(1626),AZBA  )                              D1       303
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      EQUIVALENCE (C(1632),VDELX )
      EQUIVALENCE (C(1633),VDELY )
      EQUIVALENCE (C(1634),VDELZ )
      EQUIVALENCE (C(1635),RDELX )
      EQUIVALENCE (C(1636),RDELY )
      EQUIVALENCE (C(1637),RDELZ )
      EQUIVALENCE (C(1638),VCLSNG)
      EQUIVALENCE (C(1660),VTXE  )
      EQUIVALENCE (C(1661),VTYE  )
      EQUIVALENCE (C(1662),VTZE  )
      EQUIVALENCE (C(1663),VDXB  )
      EQUIVALENCE (C(1664),VDYB  )
      EQUIVALENCE (C(1665),VDZB  )
      EQUIVALENCE (C(1676),ANGX  )
      EQUIVALENCE (C(1677),ANGY  )
      EQUIVALENCE (C(1678),ANGZ  )
      EQUIVALENCE (C( 371),RANGE  )
C
C**ADD AERO AND THRUST FORCES TO GET TOTAL ACCELERATION IN BODY AXES
      AXBA = FXBA/DMASS
      AYBA = FYBA/DMASS
      AZBA = FZBA/DMASS
C
C**RESOLVE FROM BODY TO EARTH AXES
      AXE = CFA11*AXBA+CFA21*AYBA+CFA31*AZBA
      AYE = CFA12*AXBA+CFA22*AYBA+CFA32*AZBA
      AZE = CFA13*AXBA+CFA23*AYBA+CFA33*AZBA
C
C**INTEGRATE ACCELERATIONS
      VXED = AXE
      VYED = AYE
      VZED = AZE + AGRAV
C
C** CALCULATE TOTAL MISSILE ACCELERATION IN BODY AXES
      VDXB = CFA11*VXED + CFA12*VYED + CFA13*VZED
      VDYB = CFA21*VXED + CFA22*VYED + CFA23*VZED
      VDZB = CFA31*VXED + CFA32*VYED + CFA33*VZED
      ANGX = VDXB/32.174
      ANGY = VDYB/32.174
      ANGZ = VDZB/32.174
C
C**INTEGRATE VELOCITIES TO EARTH AXES  POSITION
   10 RXED = VXE
      RYED = VYE
      RZED = VZE
C
C**TARGET MOTION
      IF (OPTARG .LE. 0.) RETURN
      VTARGD = ATHRST*AGRAV
      BPSITD= 0.
      IF (VTARG.GT.0.) BPSITD= ATURNT*AGRAV*GRAD/VTARG
C
      VTXE = VTARG*COSD(BGAMT)*COSD(BPSIT)
      VTYE = VTARG*COSD(BGAMT)*SIND(BPSIT)
      VTZE = VTARG*SIND(BGAMT)
C
      RTXED = VTXE
```

```
SUBROUTINE D1          74/74    OPT=1                    FTN 4.2+74355      07/07/75  11.06.14.        PAGE    3

  115            RTYED = VTYE                                                01
                 RTZED = VTZE                                                01
           C                                                                 01
                 VDELX = VTXE-VXE                                            01
                 VDELY = VTYE-VYE                                            01
  120            VDELZ = VTZE-VZE                                            01
           C                                                                 01
                 VCLSNG = (RDELX*VDELX+RDELY*VDELY+RDELZ*VDELZ)/RANGE        01
                 RETURN                                                      01
                 END                                                         01
```

```
SUBROUTINE D1          74/74   OPT=1                            FTN 4.2+74355      07/07/75  11.06.14.      PAGE     4

          SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS      DEF LINE     REFERENCES
    1  D1              1          105         123

 VARIABLES      SN  TYPE              RELOCATION
   3220  ADIVE      REAL                   C          REFS       12
   3132  AGRAV      REAL                   C          REFS        6        89          106        108
   3213  ANGX       REAL                   C          REFS       71   DEFINED           95
   3214  ANGY       REAL                   C          REFS       72   DEFINED           96
   3215  ANGZ       REAL                   C          REFS       73   DEFINED           97
   3134  ATHRST     REAL                   C          REFS        8       105
   3135  ATJRNT     REAL                   C          REFS        9       100
   3127  AXBA       REAL                   C          REFS       55        82           93         84    DEFINED      77
    130  AXE        REAL                              REFS       87   DEFINED           82
   3130  AYBA       REAL                   C          REFS       56        82           93         84    DEFINED      78
    131  AYE        REAL                              REFS       88   DEFINED           93
   3131  AZBA       REAL                   C          REFS       57        82           93         84    DEFINED      79
    132  AZE        REAL                              REFS       89   DEFINED           94
   3136  BGAMT      REAL                   C          REFS       10       110          111        112
   3156  BPSIT      REAL                   C          REFS       46       110          111
   3153  BPSITD     REAL                   C          REFS       45   DEFINED          107        108
      0  C          REAL       ARRAY       C          REFS        3         5            7          8         9         10        11
                                                         12      13        16           17         18        19         20        21
                                                         22      23        24           25         26        27         28        31
                                                         32      33        34           35         36        37         38        39
                                                         40      41        42           43         44        45         46        47
                                                         48      49        50           51         52        55         56        57
                                                         58      59        60           61         62        63         64        65
                                                         66      67        68           69         70        71         72        73
                                                         74
   3246  CFA11      REAL                   C          REFS       19        82           92
   3252  CFA12      REAL                   C          REFS       20        83           92
   3256  CFA13      REAL                   C          REFS       21        84           92
   3262  CFA21      REAL                   C          REFS       22        82           93
   3266  CFA22      REAL                   C          REFS       23        83           93
   3272  CFA23      REAL                   C          REFS       24        84           93
   3276  CFA31      REAL                   C          REFS       25        82           94
   3302  CFA32      REAL                   C          REFS       26        83           94
   3306  CFA33      REAL                   C          REFS       27        84           94
   3326  CRAD       REAL                   C          REFS       13       100
   3133  DMASS      REAL                   C          REFS        7        77           78         79
   2423  FXBA       REAL                   C          REFS       16        77
   2424  FYBA       REAL                   C          REFS       17        78
   2425  FZBA       REAL                   C          REFS       18        79
   3146  OPTARG     REAL                   C          REFS       11       103
    562  RANGE      REAL                   C          REFS       74       122
   3142  RDELX      REAL                   C          REFS       61       122
   3143  RDELY      REAL                   C          REFS       62       122
   3144  RDELZ      REAL                   C          REFS       63       122
   3162  RTXE       REAL                   C          REFS       48
   3157  RTXED      REAL                   C          REFS       47   DEFINED          114
   3166  RTYE       REAL                   C          REFS       50
   3163  RTYED      REAL                   C          REFS       49   DEFINED          115
   3172  RTZE       REAL                   C          REFS       52
   3167  RTZED      REAL                   C          REFS       51   DEFINED          116
   3116  RXE        REAL                   C          REFS       30
```

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      SUBROUTINE D1          74/74    OPT=1                             FTN 4.2+74355        07/07/75  11.06.14.        PAGE     5

 VARIABLES       SN  TYPE            RELOCATION
    3113  RXED        REAL                  C            REFS        37   DEFINED      100
    3122  RYE         REAL                  C            REFS        40
    3117  RYED        REAL                  C            REFS        39   DEFINED      101
    3126  RZE         REAL                  C            REFS        42
    3123  RZED        REAL                  C            REFS        41   DEFINED      102
    3717  T           REAL                  C            REFS        28
    3149  VCLSNG      REAL                  C            REFS        64   DEFINED      122
    3137  VDELX       REAL                  C            REFS        58        122   DEFINED      118
    3140  VDELY       REAL                  C            REFS        59        122   DEFINED      119
    3141  VDELZ       REAL                  C            REFS        60        122   DEFINED      120
    3176  VDXB        REAL                  C            REFS        68         95   DEFINED       92
    3177  VDYB        REAL                  C            REFS        69         96   DEFINED       93
    3200  VDZB        REAL                  C            REFS        70         97   DEFINED       94
    3152  VTARG       REAL                  C            REFS        44      2*108       110      111       112
    3147  VTARGD      REAL                  C            REFS        43   DEFINED      106
    3173  VTXE        REAL                  C            REFS        65        114       118   DEFINED      113
    3174  VTYE        REAL                  C            REFS        66        115       119   DEFINED      111
    3175  VTZE        REAL                  C            REFS        67        116       120   DEFINED      112
    3102  VXE         REAL                  C            REFS        32        100       118
    3077  VXED        REAL                  C            REFS        31         92        93       94   DEFINED       87
    3106  VYE         REAL                  C            REFS        34        101       119
    3103  VYED        REAL                  C            REFS        33         92        93       94   DEFINED       88
    3112  VZE         REAL                  C            REFS        36        102       120
    3107  VZED        REAL                  C            REFS        35         92        93       94   DEFINED       89

 EXTERNALS            TYPE   ARGS          REFERENCES
        COSD          REAL     1              2*110        111
        SIND          REAL     1                111        112

 STATEMENT LABELS                    DEF LINE   REFERENCES
     0  10            INACTIVE          100

 COMMON BLOCKS    LENGTH      MEMBERS - BIAS NAME(LENGTH)
        C            3830                 0 C      (3830)

 EQUIV CLASSES    LENGTH      MEMBERS - BIAS NAME(LENGTH)
 C      C           3830             370 RANGE   (1)              1299 FXBA    (1)              1300 FYBA    (1)
                                    1301 FZBA    (1)              1599 VXED    (1)              1602 VXE     (1)
                                    1603 VYED    (1)              1606 VYE     (1)              1607 VZED    (1)
                                    1610 VZE     (1)              1611 RXED    (1)              1614 RXE     (1)
                                    1615 RYED    (1)              1618 RYE     (1)              1619 RZED    (1)
                                    1622 RZE     (1)              1623 AXBA    (1)              1624 AYBA    (1)
                                    1625 AZBA    (1)              1626 AGRAV   (1)              1627 DMASS   (1)
                                    1628 ATHRST  (1)              1629 ATURNT  (1)              1630 BGAMT   (1)
                                    1631 VDELX   (1)              1632 VDELY   (1)              1633 VDELZ   (1)
                                    1634 RDELX   (1)              1635 RDELY   (1)              1636 RDELZ   (1)
                                    1637 VCLSNG  (1)              1638 OPTARG  (1)              1639 VTARGD  (1)
                                    1642 VTARG   (1)              1643 BPSITD  (1)              1646 BPSIT   (1)
                                    1647 RTXED   (1)              1650 RTXE    (1)              1651 RTYED   (1)
                                    1654 RTYE    (1)              1655 RTZED   (1)              1658 RTZE    (1)
                                    1659 VTXE    (1)              1660 VTYE    (1)              1661 VTZE    (1)
                                    1662 VDXB    (1)              1663 VDYB    (1)              1664 VDZB    (1)
                                    1675 ANGX    (1)              1676 ANGY    (1)              1677 ANGZ    (1)
                                    1680 ADIVE   (1)              1702 CFA11   (1)              1706 CFA12   (1)
                                    1710 CFA13   (1)              1714 CFA21   (1)              1718 CFA22   (1)
                                    1722 CFA23   (1)              1726 CFA31   (1)              1730 CFA32   (1)
                                    1734 CFA33   (1)              1750 CRAD    (1)              1933 T       (1)
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STATISTICS
  PROGRAM LENGTH              1333       91
  CM LABELED COMMON LENGTH   73668     3830
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```
      SUBROUTINE D2I
C**ROTATIONAL DYNAMICS INITIALIZATION MODULE D2IEUL
      COMMON /C/ C(3839)
      DIMENSION  IPL (100)
C**INPUT DATA
      EQUIVALENCE (C(1752),BPHIO )
      EQUIVALENCE (C(1753),BTHTO )
      EQUIVALENCE (C(1754),BPSIO )
C**INPUTS FROM MAIN PROGRAM
      EQUIVALENCE (C(2561),N      )
      EQUIVALENCE (C(2562),IPL    )
C**STATE VARIABLE OUTPUTS
      EQUIVALENCE (C(1703),CFA11 )
      EQUIVALENCE (C(1707),CFA12 )
      EQUIVALENCE (C(1711),CFA13 )
      EQUIVALENCE (C(1715),CFA21 )
      EQUIVALENCE (C(1719),CFA22 )
      EQUIVALENCE (C(1723),CFA23 )
      EQUIVALENCE (C(1727),CFA31 )
      EQUIVALENCE (C(1731),CFA32 )
      EQUIVALENCE (C(1735),CFA33 )
C**OTHER OUTPUTS
      EQUIVALENCE (C(1755),A021  )
      EQUIVALENCE (C(1756),A022  )
      EQUIVALENCE (C(1757),A023  )
      EQUIVALENCE (C(1758),A031  )
      EQUIVALENCE (C(1759),A032  )
      EQUIVALENCE (C(1760),A033  )
C**INITIAL CALCULATION OF EULER ANGLE MATRIX OF DIRECTION COSINES (CFA)
      USPHI = SIND(BPHIO)
      UCPHI = COSD(BPHIO)
      USTHT = SIND(BTHTO)
      UCTHT = COSD(BTHTO)
      USPSI = SIND(BPSIO)
      UCPSI = COSD(BPSIO)
      CFA11 = UCPSI*UCTHT
      CFA12 = USPSI*UCTHT
      CFA13 = -USTHT
      CFA21 = -USPSI*UCPHI+UCPSI*USTHT*USPHI
      CFA22 = UCPSI*UCPHI+USPSI*USTHT*USPHI
      CFA23 = UCTHT*USPHI
      CFA31 = UCPSI*USTHT*UCPHI+USPSI*USPHI
      CFA32 = USPSI*USTHT*UCPHI-UCPSI*USPHI
      CFA33 = UCTHT*UCPHI
C
C**INITIALIZE MATRIX COEF FOR FREE GYRO MODEL(S)
C
C**INTEGRATED PARAMATER LIST (IPL) FOR WPD,WQD,WRD,AND CFAD
      IPL(N) = 1700
      IPL(N+1) = 1704
      IPL(N+2) = 1708
      IPL(N+3) = 1712
      IPL(N+4) = 1716
      IPL(N+5) = 1720
      IPL(N+6) = 1724
      IPL(N+7) = 1728
      IPL(N+8) = 1732
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            IPL(N+9)  = 1736                                  02
            IPL(N+10) = 1740                                  02
   60       IPL(N+11) = 1744                                  02
            N = N+12                                          02
            RETURN                                            02
            END                                               02
```

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SUBROUTINE D2I          74/74    OPT=1                              FTN 4.2+74355       07/07/75  11.06.21.        PAGE      3

        SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS       DEF LINE       REFERENCES
    1  D2I              1            62

 VARIABLES       SN  TYPE                 RELOCATION
  3332  A021         REAL                     C           REFS       23
  3333  A022         REAL                     C           REFS       24
  3334  A023         REAL                     C           REFS       25
  3335  A031         REAL                     C           REFS       26
  3336  A032         REAL                     C           REFS       27
  3337  A033         REAL                     C           REFS       28
  3327  BPHID        REAL                     C           REFS        6        30        31
  3331  BPSID        REAL                     C           REFS        8        34        35
  3330  BTHTD        REAL                     C           REFS        7        32        33
     0  C            REAL          ARRAY      C           REFS        3         5         7         8        10        11        13
                                                            14       15        16        17        18        19        20        21
                                                            23       24        25        26        27        28
  3246  CFA11        REAL                     C           REFS       13   DEFINED        36
  3252  CFA12        REAL                     C           REFS       14   DEFINED        37
  3256  CFA13        REAL                     C           REFS       15   DEFINED        38
  3262  CFA21        REAL                     C           REFS       16   DEFINED        39
  3266  CFA22        REAL                     C           REFS       17   DEFINED        40
  3272  CFA23        REAL                     C           REFS       18   DEFINED        41
  3276  CFA31        REAL                     C           REFS       19   DEFINED        42
  3302  CFA32        REAL                     C           REFS       20   DEFINED        43
  3306  CFA33        REAL                     C           REFS       21   DEFINED        44
  3001  IPL          INTEGER       ARRAY      C           REFS        4        11   DEFINED        49        50        51        52
                                                            53       54        55        56        57        58        59        60
  3000  N            INTEGER                  C           REFS       10        49        50        51        52        53        54
                                                            55       56        57        58        59        60        61
                                                       DEFINED       61
    73  UCPHI        REAL                                 REFS       39        40        42        43        44
                                                       DEFINED       31
    77  UCPSI        REAL                                 REFS       36        39        40        42        43
                                                       DEFINED       35
    75  UCTHT        REAL                                 REFS       36        37        41        44   DEFINED        33
    72  USPHI        REAL                                 REFS       39        40        41        42        43
                                                       DEFINED       30
    76  USPSI        REAL                                 REFS       37        33        40        42        43
                                                       DEFINED       34
    74  USTHT        REAL                                 REFS       38        39        40        42        43
                                                       DEFINED       32

 EXTERNALS            TYPE    ARGS        REFERENCES
         COSD         REAL      1             31        33        35
         SIND         REAL      1             30        32        34

 COMMON BLOCKS     LENGTH      MEMBERS - BIAS NAME(LENGTH)
         C          3830               0 C       (3830)

 EQUIV CLASSES     LENGTH      MEMBERS - BIAS NAME(LENGTH)
 C       C          3830          1702 CFA11   (1)            1706 CFA12   (1)            1710 CFA13   (1)
                                  1714 CFA21   (1)            1718 CFA22   (1)            1722 CFA23   (1)
                                  1726 CFA31   (1)            1730 CFA32   (1)            1734 CFA33   (1)
                                  1751 BPHID   (1)            1752 BTHTD   (1)            1753 BPSID   (1)
                                  1754 A021    (1)            1755 A022    (1)            1756 A023    (1)
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EQUIV CLASSES   LENGTH      MEMBERS - BIAS NAME(LENGTH)
                                  1757 A031    (1)             1758 A032    (1)             1759 A033   (1)
                                  2560 N       (1)             2561 IPL     (100)

STATISTICS
  PROGRAM LENGTH                1008B      64
  CM LABELED COMMON LENGTH     73666B    3830
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      SUBROUTINE D2                                                   D2        65
C**   ROTATIONAL DYNAMICS MODULE                                      D2        66
      COMMON /C/ C(3830)                                              D2        67
C                                                                     D2        68
C**DATA INPUTS                                                        D2        69
      EQUIVALENCE (C(1748),FMIX  )                                    D2        70
      EQUIVALENCE (C(1749),FMIY  )                                    D2        71
      EQUIVALENCE (C(1750),FMIZ  )                                    D2        72
      EQUIVALENCE (C(1751),CRAD  )                                    D2        73
      EQUIVALENCE (C(3503),OPTN3)                                     D2        74
C                                                                     D2        75
C**INPUTS FROM OTHER MODULES                                          D2        76
      EQUIVALENCE (C(1303),FMXBA )                                    D2        77
      EQUIVALENCE (C(1304),FMYBA )                                    D2        78
      EQUIVALENCE (C(1305),FMZBA )                                    D2        79
C                                                                     D2        80
C**STATE VARIABLE OUTPUTS                                             D2        81
      EQUIVALENCE (C(1700),CFA11D)                                    D2        82
      EQUIVALENCE (C(1703),CFA11 )                                    D2        83
      EQUIVALENCE (C(1704),CFA12D)                                    D2        84
      EQUIVALENCE (C(1707),CFA12 )                                    D2        85
      EQUIVALENCE (C(1708),CFA13D)                                    D2        86
      EQUIVALENCE (C(1711),CFA13 )                                    D2        87
      EQUIVALENCE (C(1712),CFA21D)                                    D2        88
      EQUIVALENCE (C(1715),CFA21 )                                    D2        89
      EQUIVALENCE (C(1716),CFA22D)                                    D2        90
      EQUIVALENCE (C(1719),CFA22 )                                    D2        91
      EQUIVALENCE (C(1720),CFA23D)                                    D2        92
      EQUIVALENCE (C(1723),CFA23 )                                    D2        93
      EQUIVALENCE (C(1724),CFA31D)                                    D2        94
      EQUIVALENCE (C(1727),CFA31 )                                    D2        95
      EQUIVALENCE (C(1728),CFA32D)                                    D2        96
      EQUIVALENCE (C(1731),CFA32 )                                    D2        97
      EQUIVALENCE (C(1732),CFA33D)                                    D2        98
      EQUIVALENCE (C(1735),CFA33 )                                    D2        99
      EQUIVALENCE (C(1736),WPD   )                                    D2       100
      EQUIVALENCE (C(1739),WP    )                                    D2       101
      EQUIVALENCE (C(1740),WQD   )                                    D2       102
      EQUIVALENCE (C(1743),WQ    )                                    D2       103
      EQUIVALENCE (C(1744),WRD   )                                    D2       104
      EQUIVALENCE (C(1747),WR    )                                    D2       105
C                                                                     D2       106
C**INTEGRATE BODY ANGULAR RATES                                       D2       107
      IF (OPTN3.GT.0.) GO TO 55                                       D2       108
      WPD = CRAD*FMXBA/FMIX                                           D2       109
   55 WQD = (CRAD*FMYBA+(FMIZ-FMIX)*WP*WR/CRAD)/FMIY                  D2       110
   65 WRD = (CRAD*FMZBA+(FMIX-FMIY)*WP*WQ/CRAD)/FMIZ                  D2       111
C                                                                     D2       112
C**INTEGRATE ATTITUDE DIRECTION COSINES                               D2       113
   49 CFA11D=(CFA21*WR-CFA31*WQ)/CRAD                                 D2       114
      CFA12D=(CFA22*WR-CFA32*WQ)/CRAD                                 D2       115
      CFA13D=(CFA23*WR-CFA33*WQ)/CRAD                                 D2       116
      CFA21D = (CFA31*WP-CFA11*WR)/CRAD                               D2       117
      CFA22D = (CFA32*WP-CFA12*WR)/CRAD                               D2       118
      CFA23D = (CFA33*WP-CFA13*WR)/CRAD                               D2       119
      CFA31D = (CFA11*WQ-CFA21*WP)/CRAD                               D2       120
      CFA32D = (CFA12*WQ-CFA22*WP)/CRAD                               D2       121
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SUBROUTINE D2          74/74    OPT=1                        FTN 4.2+74355        07/07/75  11.06.25.        PAGE    2

                 C*ASSD = (C*A13*WQ-C*A23*WP)/CRAD                                         D2      122
                 RETURN                                                                    D2      123
      60         END                                                                       D2      124
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```
        SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS      DEF LINE      REFERENCES
    1  D2              1             59

 VARIABLES      SN  TYPE          RELOCATION
     0  C           REAL        ARRAY   C          REFS       3       5       7       8       9      10      13
                                                             14      15      18      19      20      21      22      23
                                                             24      25      26      27      28      29      30      31
                                                             32      33      34      35      36      37      38      39
                                                             40      41
  3246  CFA11       REAL                C          REFS      19      53      56
  3243  CFA11D      REAL                C          REFS      18  DEFINED     50
  3252  CFA12       REAL                C          REFS      21      54      57
  3247  CFA12D      REAL                C          REFS      20  DEFINED     51
  3256  CFA13       REAL                C          REFS      23      55      58
  3253  CFA13D      REAL                C          REFS      22  DEFINED     52
  3262  CFA21       REAL                C          REFS      25      50      56
  3257  CFA21D      REAL                C          REFS      24  DEFINED     53
  3266  CFA22       REAL                C          REFS      27      51      57
  3263  CFA22D      REAL                C          REFS      26  DEFINED     54
  3272  CFA23       REAL                C          REFS      29      52      58
  3267  CFA23D      REAL                C          REFS      28  DEFINED     55
  3276  CFA31       REAL                C          REFS      31      50      53
  3273  CFA31D      REAL                C          REFS      30  DEFINED     56
  3302  CFA32       REAL                C          REFS      33      51      54
  3277  CFA32D      REAL                C          REFS      32  DEFINED     57
  3306  CFA33       REAL                C          REFS      35      52      55
  3303  CFA33D      REAL                C          REFS      34  DEFINED     58
  3326  CRAD        REAL                C          REFS       9      45     2*46    2*47      50      51      52
                                                             53      54      55      56      57      58
  3323  FMIX        REAL                C          REFS       6      45      46      47
  3324  FMIY        REAL                C          REFS       7      45      47
  3325  FMIZ        REAL                C          REFS       8      46      47
  2426  FMXBA       REAL                C          REFS      13      45
  2427  FMYBA       REAL                C          REFS      14      46
  2430  FMZBA       REAL                C          REFS      15      47
  3656  CPTN3       REAL                C          REFS      10      44
  3312  WP          REAL                C          REFS      37      45      47      53      54      55      56
                                                             57      58
  3307  WPD         REAL                C          REFS      36  DEFINED     45
  3316  WQ          REAL                C          REFS      39      47      50      51      52      56      57
                                                             58
  3313  WQD         REAL                C          REFS ,    38  DEFINED     46
  3322  WR          REAL                C          REFS      41      46      50      51      52      53      54
                                                             55
  3317  WRD         REAL                C          REFS      40  DEFINED     47

 STATEMENT LABELS               DEF LINE   REFERENCES
     0  49         INACTIVE        50
     0  55                         46          44
     0  65         INACTIVE        47

 COMMON BLOCKS     LENGTH      MEMBERS - BIAS NAME(LENGTH)
         C          3030                 0 C    (3030)
```

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     SUBROUTINE 02          74/74    OPT=1                        FTN 4.2+74355      07/07/75  11.06.25.      PAGE     4

  EQUIV CLASSES    LENGTH      MEMBERS - BIAS NAME(LENGTH)
C        C          3838            1302 FMXBA   (1)            1303 FMYBA   (1)            1304 FMZBA   (1)
                                    1699 CFA11D  (1)            1702 CFA11   (1)            1703 CFA12D  (1)
                                    1706 CFA12   (1)            1707 CFA13D  (1)            1710 CFA13   (1)
                                    1711 CFA21D  (1)            1714 CFA21   (1)            1715 CFA22D  (1)
                                    1718 CFA22   (1)            1719 CFA23D  (1)            1722 CFA23   (1)
                                    1723 CFA31D  (1)            1726 CFA31   (1)            1727 CFA32D  (1)
                                    1730 CFA32   (1)            1731 CFA33D  (1)            1734 CFA33   (1)
                                    1735 WPD     (1)            1738 WP      (1)            1739 WQD     (1)
                                    1742 WQ      (1)            1743 WRD     (1)            1746 WR      (1)
                                    1747 FMIX    (1)            1748 FMIY    (1)            1749 FMIZ    (1)
                                    1750 CRAD    (1)            3502 OPTNB   (1)

  STATISTICS
    PROGRAM LENGTH                 64B      52
    CM LABELED COMMON LENGTH     7366B    3830
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```
      SUBROUTINE SII
C**SEEKER INIT.MODULE
      COMMON /C/ C(3830)
      DIMENSION IZ(50), IY(50), ISNDX(40)
      EQUIVALENCE (C(3634), ISNDX), (C(3512), I3512)
      EQUIVALENCE (C( 470), BTGERR)
      EQUIVALENCE (C( 471), BPGERR)
      EQUIVALENCE (C( 465),  SDY)
      EQUIVALENCE (C( 466),  SDZ)
    1 FORMAT(5X,2HBZ,6X,4(I13,I11)/(13X,4(I13,I11)))
    2 FORMAT(5X,2HBY,6X,4(I13,I11)/(13X,4(I13,I11)))
      EQUIVALENCE (C(11),BY)
      EQUIVALENCE (C(12),BZ)
      EQUIVALENCE(C(2011),KSTEP)
      EQUIVALENCE(C(600),IZ)
      EQUIVALENCE(C(650),IY)
      DIMENSION IPL(100)
      EQUIVALENCE (C(452),SWP)
      EQUIVALENCE(C(0411),WLQ)
      EQUIVALENCE(C(0415),WLR)
      EQUIVALENCE (C(0419),WLQS)
      EQUIVALENCE (C(0423),WLRS)
      EQUIVALENCE (C(0427),BTHTG)
      EQUIVALENCE (C(0431),BPSIG)
      EQUIVALENCE (C(2561),N)
      EQUIVALENCE (C(2562),IPL)
      EQUIVALENCE (C(3504),OPTN4)
      EQUIVALENCE (C(2662)  ,DERSV)
      IPL(N)=424
      IPL(N+1)=428
      IPL(N+2)=408
      IPL(N+3)=412
      IPL(N+4)=416
      IPL(N+5)=420
      N=N+6
      C(411)=0.
      C(415)=0.
      C(419)=0.
      C(423)=0.
       BY=0.
      BZ=0.
      SDY = 0.
      SDZ = 0.
      DO 10 I = 1, I3512
      IDO = I
C
C MONTE CARLO SEEKER OUTPUT STARTING VALUES
C
      IF(ISNDX(I).EQ.11) CALL MCARLO (DUM, 1, IDO)
      IF(ISNDX(I).EQ.12) CALL MCARLO (DUM, 1, IDO)
      IF(ISNDX(I).EQ.460) CALL MCARLC (DUM, 1, IDO)
      IF(ABS(BY).GT.0. ) BY = SIGN(1.,BY)
      IF(ABS(BZ).GT.0. ) BZ = SIGN(1.,BZ)
C
C  MONTE CARLO SEEKER POINTING ERROR
C
      IF(ISNDX(I).EQ.470) CALL MCARLO (DUM, 1, IDO)
```

```
      IF(ISNDX(I).EQ.471) CALL MCARLO (DUM, 1, IDO)
C
C ** MONTECARLO SEEKER DRIFT
      IF(ISNDX(I).EQ.455) CALL MCARLO (DUM, 1, IDO)
      IF(ISNDX(I).EQ.466) CALL MCARLC (DUM, 1, IDO)
C
   10 CONTINUE
      BTHTG = BTHTG + BTGERR
      BPSIG = BPSIG + BPGERR
C
      WLQS=SWP*(BTHTG-BPSIG)
      WLQ=SWP*(BTHTG-BPSIG)
      WLR=SWP*(BTHTG+BPSIG)
      WLRS=SWP*(BTHTG+BPSIG)
      C(13) = -1.
      DENSV=.002
      C(451)=0.
      C(452)=0.
      C(453)=0.
      C(454)=0.
      IF(OPTN4.GT.1.) GO TO 30
      C(451)=1.
      C(452)=1.
      C(453)=1.
      C(454)=1.
   30 CONTINUE
      NI=1
      MI=1
      SET=0.
      DO 200 I=1,50
      IZ(I)=0
  200 IY(I)=0
      RETURN
      ENTRY QD
      IF(SET.GT.0.) RETURN
      IF(NI.GT.50) RETURN
      IF(MI.LE.10) GO TO 100
      NI=NI+1
      MI=1
  100 IZ(NI)=IZ(NI)+INT(BZ+2.)*10**(10-MI)
      IY(NI)=IY(NI)+INT(BY+2.)*10**(10-MI)
      MI=MI+1
      RETURN
      ENTRY S8
      IF(SET.GT.0..OR.KSTEP.NE.2) RETURN
      SET=1.
      WRITE(6,1) (IZ(I),I=1,NI)
      WRITE(6,2) (IY(I),I=1,NI)
      RETURN
      END
```

```
      SUBROUTINE S1I        74/74   OPT=1                        FTN 4.2+74355      07/07/75  11.06.29.      PAGE    3

      SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS      DEF LINE     REFERENCES
   126  QJ              91          92          93          100
     1  S1I              1          90
   160  S8             101         102         106

 VARIABLES       SN  TYPE             RELOCATION
   726  BPSERR      REAL                  C          REFS         7         65
   656  BPSIG       REAL                  C          REFS        24         65         68         69         70         71
                                                 DEFINED         66
   725  BTGERR      REAL                  C          REFS         6         65
   652  BTHTS       REAL                  C          REFS        23         65         50         69         70         71
                                                 DEFINED         65
    12  BY          REAL                  C          REFS        12        2*62        38    DEFINED         40         52
    13  BZ          REAL                  C          REFS        13        2*63        37    DEFINED         41         53
     0  C           REAL        ARRAY     C          REFS         3        2*5          6          7          8          9         12
                                                         13        14         15         16         18         19         20         21
                                                         22        23         24         25         26         27         28
                                                 DEFINED         36         37         38         39         72         74         75
                                                         76        77         79         80         81         82
  3145  DERSV       REAL                  C          REFS        28    DEFINED         73
   244  DUM         REAL                             REFS        49         50         51         57         58         61         62
   242  I           INTEGER                          REFS        45         49         50         51         57         58         61
                                                         62        88         89        104        105    DEFINED         44         87
                                                        104       105
   243  IDD         INTEGER                          REFS        49         50         51         57         58         61         62
                                                 DEFINED         45
  3001  IPL         INTEGER     ARRAY     C          REFS        17         25    DEFINED         29         30         31         32
                                                         33        34
  7001  ISNDX       INTEGER     ARRAY     C          REFS         4          5         49         50         51         57         58
                                                         61        62
  1211  IY          INTEGER     ARRAY     C          REFS         4         15         98        105    DEFINED         69         98
  1127  IZ          INTEGER     ARRAY     C          REFS         4         15         37        104    DEFINED         88         97
  3667  I3S12       INTEGER               C          REFS         5         44
  3732  KSTEP       INTEGER               C          REFS        14        102
   246  MI          INTEGER                          REFS        94         97         98         99    DEFINED         85         96
                                                         99
  3000  N           INTEGER               C          REFS        25         29         30         31         32         33         34
                                                         35   DEFINED         35
   245  NI          INTEGER                          REFS        93         95        2*97       2*98        104        105
                                                 DEFINED         84         93
  3657  OPTNS       REAL                  C          REFS        27         78
   720  SDY         REAL                  C          REFS         8    DEFINED         42
   721  SDZ         REAL                  C          REFS         9    DEFINED         43
   247  SET         REAL                             REFS        92        102    DEFINED         86        103
   703  SWP         REAL                  C          REFS        18         68         59         78         71
   632  WL1         REAL                  C          REFS        19    DEFINED         69
   642  WL2S        REAL                  C          REFS        21    DEFINED         68
   636  WLR         REAL                  C          REFS        20    DEFINED         70
   646  WLRS        REAL                  C          REFS        22    DEFINED         71

 FILE NAMES         MODE
      TAPE6         FMT                  WRITES         104        105
```

```
EXTERNALS           TYPE   ARGS         REFERENCES
      PCARLO                3              49        50        51        57        58        61        62

INLINE FUNCTIONS    TYPE   ARGS          DEF LINE  REFERENCES
      ABS         REAL       1  INTRIN              52        53
      INT         INTEGER    1  INTRIN              97        98
      SIGN        REAL       2  INTRIN              52        53

STATEMENT LABELS              DEF LINE   REFERENCES
  213  1        FMT               10        104
  220  2        FMT               11        105
    0  10                         64         44
  116  30                         83         78
  140  100                        97         94
    0  200                        89         87

LOOPS  LABEL    INDEX       FROM-TO     LENGTH    PROPERTIES
   22  10     * I           44 64       528                   EXT REFS
  123  200      I           67 89        23        INSTACK

COMMON BLOCKS   LENGTH      MEMBERS - BIAS NAME(LENGTH)
      C           3830                0 C      (3830)

EQUIV CLASSES   LENGTH      MEMBERS - BIAS NAME(LENGTH)
      C           3830             10 BY     (1)                 11 BZ      (1)               410 WLQ     (1)
                                  414 WLR    (1)                418 WLQS    (1)               422 WLPS    (1)
                                  426 BTHTG  (1)                430 BPSIG   (1)               451 SWP     (1)
                                  464 SDY    (1)                465 SDZ     (1)               459 BTGERR  (1)
                                  470 BPGERR (1)                599 IZ      (50)              649 IY      (50)
                                 2010 KSTEP  (1)               2560 N       (1)              2551 IPL     (100)
                                 2661 DERSV  (1)               3503 OPTN4   (1)              3511 I3512   (1)
                                 3633 ISNDX  (40)

STATISTICS
  PROGRAM LENGTH               2503      168
  CM LABELED COMMON LENGTH    73668     3830
```

```
      SUBROUTINE S1
C**SEEKER MODULE
C
      COMMON /C/ C(3830)
      EQUIVALENCE (C(2000),T      )
  101 FORMAT (30H0      TARGET ACQUISITION    T = ,F8.4,
     *       10H   EPS Z = ,1PE11.3,10H   EPS Y = ,1PE11.3)
  102 FORMAT (30H0      PITCH PLANE TRACK     T = ,F8.4,
     *       10H   EPS Z = ,1PE11.3,10H   EPS Y = ,1PE11.3)
  103 FORMAT (30H0      YAW   PLANE TRACK     T = ,F8.4,
     *       10H   EPS Z = ,1PE11.3,10H   EPS Y = ,1PE11.3)
C
C**INPUT DATA
      EQUIVALENCE (C( 445),RLOCK )
      EQUIVALENCE (C( 446),DT    )
      EQUIVALENCE (C( 447),BOB   )
      EQUIVALENCE (C( 448),CFOVZ )
      EQUIVALENCE (C( 449),CFOVY )
      EQUIVALENCE (C( 450),GSK   )
      EQUIVALENCE (C( 451),SEPS  )
      EQUIVALENCE (C( 452),SWP   )
      EQUIVALENCE (C(0456),GS    )
      EQUIVALENCE (C(0457),WSL   )
      EQUIVALENCE (C(0458),WSN   )
      EQUIVALENCE (C(0459),WLZ   )
C
      EQUIVALENCE (C( 460),ST    )
      EQUIVALENCE (C( 461),CAGE  )
      EQUIVALENCE (C( 462),TKRZ  )
      EQUIVALENCE (C( 463),TKRY  )
      EQUIVALENCE (C( 464),TRKZY )
C
C**INPUTS FROM OTHER MODULES
      EQUIVALENCE (C(0371),RANGE )
      EQUIVALENCE (C(0372),RXBA  )
      EQUIVALENCE (C(0373),RYBA  )
      EQUIVALENCE (C(0374),RZBA  )
      EQUIVALENCE (C(1739),WP    )
      EQUIVALENCE (C(1743),WQ    )
      EQUIVALENCE (C(1747),WR    )
C
C**STATE VARIABLE OUTPUTS
      EQUIVALENCE (C(0408),WLQD  )
      EQUIVALENCE (C(0411),WLQ   )
      EQUIVALENCE (C(0412),WLRD  )
      EQUIVALENCE (C(0415),WLR   )
      EQUIVALENCE (C(0416),WLQSD )
      EQUIVALENCE (C(0419),WLQS  )
      EQUIVALENCE (C(0420),WLRSD )
      EQUIVALENCE (C(0423),WLRS  )
      EQUIVALENCE (C(0424),BTHTGD)
      EQUIVALENCE (C(0427),BTHTG )
      EQUIVALENCE (C(0428),BPSIGD)
      EQUIVALENCE (C(0431),BPSIG )
C
C**OTHER OUTPUTS
      EQUIVALENCE (C(11),BY)
```

```
      EQUIVALENCE (C(12),BZ)
      EQUIVALENCE (C(0403),WLANQ )
      EQUIVALENCE (C(0407),WLANR )
      EQUIVALENCE (C(0435),BEPSZ )
      EQUIVALENCE (C(0436),BEPSY )
      EQUIVALENCE (C(0437),WZ    )
      EQUIVALENCE (C(0438),WY    )
      EQUIVALENCE (C(0439),BGDEFL)
      EQUIVALENCE (C( 465),  SDY)
      EQUIVALENCE (C( 466),  SDZ)
C
C**DIRECTION COSINES FOR BODY TO PLATFORM TRANSFORMATION
      BTACT = BTHTG
      BPACT = BPSIG
      UCT=COSD(BTACT)
      UST=SIND(BTACT)
      UCP=COSD(BPACT)
      USP=SIND(BPACT)
      UB11 = UCT*UCP
      UB12 = UCT*USP
      UB13 =-UST
      UB21 =-USP
      UB22 = UCP
      UB23 = 0.
      UB31 = UST*UCP
      UB32 = UST*USP
      UB33 = UCT
C
C** CALCULATE TOTAL DEFLECTION OF GIMBALS
      BGDEFL=SQRT(BTHTG**2+BPSIG**2)
C
C**TRANSFORM LOS FROM BODY TO GIMBAL AXES
      RXG = UB11*RXBA+UB12*RYBA+UB13*RZBA
      RYG = UB21*RXBA+UB22*RYBA+UB23*RZBA
      RZG = UB31*RXBA+UB32*RYBA+UB33*RZBA
C
C**LOS ERRORS IN PLATFORM COORDINATES
      BEPSZ = ATAND(-RZG,RXG)
      BEPSY = ATAND( RYG,RXG)
C
C**SEEKER OUTPUT SIGNALS
C
C**QUADRANT TRACKER
   80 CONTINUE
      IF(C(1975).LE.0.) GO TO 82
      IF(T.LT.(ST-.000001)) GO TO 82
      IF(C(13).LE.0.) GO TO 820
      C(13) = -1.
      ST = T
      C(2564) = DT / AINT(DT / C(2764))
  820 CONTINUE
      ST = ST + DT
      IF (RANGE .GT. RLOCK) GO TO 81
      CZ = 2.*BEPSZ/CFOVZ
      CY = 2.*BEPSY/CFOVY
      IF (CZ**2 .GT. 1.-CY**2) GO TO 81
      BZ = SIGN(1.,BEPSZ)
```

```
      BY = SIGN(1.,BEPSY)
      TKOB = BDB/2.*(RANGE/32810.)**2
      IF (ABS(BEPSZ).LT.TKOB) BZ = 0.
      IF (ABS(BEPSY).LT.TKOB) BY = 0.
      CALL QD
      IF (CAGE .GT. 0.) GO TO 82
      UZ = BZ
      UY = BY
      CAGE = 1.
      WRITE(6,101) T, BEPSZ, BEPSY
      GO TO 92
   81 BZ = 0.
      BY = 0.
C**SEEKER COMPENSATION
   82 WLAMQ = BZ*GS
      WLAMR = BY*GS
      WQP = WLAMQ
      WRP = WLAMR
      IF (WSL .LE. 0.) GO TO 83
      WLQD = WLAMQ
      WLRD = WLAMR
      WLQD = WLQD + SEPS
      WLRD = WLRD + SEPS
      WQP = WLQD/WSL + WLQ
      WRP = WLRD/WSL + WLR
      WLAMQ = WQP
      WLAMR = WRP
      IF (WSN .LE. 0.) GO TO 83
      WLQSD = WSN*(WQP - WLQS)
      WLRSD = WSN*(WRP - WLRS)
      WQP = WLQSD/WL2 + WLQS
      WRP = WLRSD/WL2 + WLRS
C**SEEKER SWITCHING LOGIC
   83 IF (CAGE .LE. 0.) GO TO 30
C  PITCH PLANE
   10 IF (TKRZ .GT. 0.) GO TO 20
      IF (BZ*UZ .GE. 0.) GO TO 12
      TKRZ = 1.
      WRITE(6,102) T, BEPSZ, BEPSY
      IF(TKRY .GT. 0.)TRKZY=1.
      GO TO 20
   12 WLAMQ = BZ*GSX
      WQP = WLAMQ
      WLQD = 0.
      WLQSD = 0.
      UZ = BZ
C  YAW PLANE
   20 IF (TKRY .GT. 0.) GO TO 30
      IF (BY*UY .GE. 0.) GO TO 22
      TKRY = 1.
      WRITE(6,103) T, BEPSZ, BEPSY
      IF(TKRZ .GT. 0.)TRKZY=1.
      GO TO 30
   22 WLAMR = BY*GSX
      WRP = WLAMR
      WLRD = 0.
      WLRSD = 0.
```

```
            UY = BY                                               S1     280
   30 CONTINUE                                                    S1     281
C                                                                 S1     282
C**MISSILE BODY RATES IN GIMBAL AXES                              S1     283
      WZ = UB31*WP+UB32*WQ+UB33*WR                                S1     284
      WY = UB21*WP+UB22*WQ+UB23*WR                                S1     285
C                                                                 S1     286
C**GIMBAL COUPLING                                                S1     287
      UZK = SWP*(-BTHTG + .1*BPSIG)                               S1     288
      UYK = SWP*(-BPSIG - .1*BTHTG)                               S1     289
      UZK = UZK + SDZ                                             S1     290
      UYK = UYK + SDY                                             S1     291
C                                                                 S1     292
C**GIMBAL ANGLE DERIVATIVES                                       S1     293
      BTHTGD = WQP + UZK - WY                                     S1     294
      BPSIGD = WRP + UYK - WZ/UB33                                S1     295
C                                                                 S1     296
      IF (CAGE .GT. 0.) RETURN                                    S1     297
      WLAMQ = 0.                                                  S1     298
      WLAMR = 0.                                                  S1     299
      WLQD = 0.                                                   S1     300
      WLRD = 0.                                                   S1     301
      WLQSD = 0.                                                  S1     302
      WLRSD = 0.                                                  S1     303
      BTHTGD = 0.                                                 S1     304
      BPSIGD = 0.                                                 S1     305
      RETURN                                                      S1     306
      END                                                         S1     307
C**HELFIRE AUTOPILOT INITIATION MODULE                             S1     308
C**HIGH FREQ. MODEL                                               S4       2
```

```
          SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS      DEF LINE     REFERENCES
    1  S1               1        189        198

 VARIABLES        SN  TYPE              RELOCATION
   676  BDS          REAL                    C          REFS        16       116
   663  BEPSY        REAL                    C          REFS        62       112       115       118       124       153       165
                                                     DEFINED        96
   662  BEPSZ        REAL                    C          REFS        61       111       114       117       124       153       165
                                                     DEFINED        95
   660  BGDEFL       REAL                    C          REFS        65   DEFINED        97
   364  BPACT        REAL                               REFS        74        76   DEFINED        71
   656  BPSIG        REAL                    C          REFS        54        71        87       180       181
   653  BPSIGD       REAL                    C          REFS        53   DEFINED       187       197
   363  BTACT        REAL                               REFS        72        73   DEFINED        70
   652  BTHTG        REAL                    C          REFS        52        79        87       180       181
   647  BTHTGD       REAL                    C          REFS        51   DEFINED       186       196
    12  BY           REAL                    C          REFS        57       122       130       168       160       172
                                                     DEFINED       115       118       127
    13  BZ           REAL                    C          REFS        58       121       129       151       156       160
                                                     DEFINED       114       117       126
     0  C            REAL         ARRAY      C          REFS         4         5        14        15        16        17        18
                                                            19        20        21        22        23        24        25        27
                                                            28        29        30        31        34        35        36        37
                                                            38        39        40        43        44        45        46        47
                                                            48        49        50        51        52        53        54        57
                                                            58        59        60        61        62        63        64        65
                                                            66        67       102       104       107   DEFINED       105       107
   714  CASE         REAL                    C          REFS        28       120       148       189   DEFINED       123
   700  CFOVY        REAL                    C          REFS        18       112
   677  CFOVZ        REAL                    C          REFS        17       111
   406  CY           REAL                               REFS       113   DEFINED       112
   405  CZ           REAL                               REFS       113   DEFINED       111
   675  DT           REAL                    C          REFS        15     2*107       109
   707  GS           REAL                    C          REFS        22       129       130
   701  GSX          REAL                    C          REFS        19       156       160
   562  RANGE        REAL                    C          REFS        34       110       116
   674  RLOCK        REAL                    C          REFS        14       110
   563  RX3A         REAL                    C          REFS        35        90        91        92
   402  RXS          REAL                               REFS        95        96   DEFINED        90
   564  RY3A         REAL                    C          REFS        36        90        91        92
   403  RYS          REAL                               REFS        96   DEFINED        91
   565  RZ3A         REAL                    C          REFS        37        90        91        92
   404  RZS          REAL                               REFS        95   DEFINED        92
   720  SDY          REAL                    C          REFS        66       103
   721  SDZ          REAL                    C          REFS        67       102
   702  SEPS         REAL                    C          REFS        20       135       137
   713  ST           REAL                    C          REFS        27       103       109   DEFINED       106       109
   703  SWP          REAL                    C          REFS        21       180       181
  3717  T            REAL                    C          REFS         5       103       106       124       158       165
   407  TKOB         REAL                               REFS       117       113   DEFINED       116
   716  TKRY         REAL                    C          REFS        30       154       162   DEFINED       164
   715  TKRZ         REAL                    C          REFS        29       150       166   DEFINED       152
   717  TKRZY        REAL                    C          REFS        31   DEFINED       154       166
   371  UB11         REAL                               REFS        90   DEFINED        76
   372  UB12         REAL                               REFS        90   DEFINED        77
```

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SUBROUTINE S1          74/74    OPT=1                          FTN 4.2+74355       07/07/76  11.06.31.       PAGE     6

VARIABLES       SN  TYPE            RELOCATION
  373  UB13        REAL                                 REFS        90   DEFINED      78
  374  UB21        REAL                                 REFS        91       177   DEFINED        79
  375  UB22        REAL                                 REFS        91       177   DEFINED        80
  376  UB23        REAL                                 REFS        91       177   DEFINED        81
  377  UB31        REAL                                 REFS        92       175   DEFINED        82
  400  UB32        REAL                                 REFS        92       175   DEFINED        83
  401  UB33        REAL                                 REFS        92       176       157   DEFINED        84
  367  UCP         REAL                                 REFS        75        80        52   DEFINED        74
  365  UCT         REAL                                 REFS        76        77        54   DEFINED        72
  370  USP         REAL                                 REFS        77        79        53   DEFINED        75
  366  UST         REAL                                 REFS        78        82        53   DEFINED        73
  411  UY          REAL                                 REFS       163   DEFINED       122       172
  415  UYC         REAL                                 REFS       183       187   DEFINED       181       183
  410  UZ          REAL                                 REFS       151   DEFINED       121       160
  414  UZK         REAL                                 REFS       182       185   DEFINED       180       182
  622  WLAMQ       REAL                C                REFS        59       131       134       157   DEFINED       129       140
                                                         156       190
  626  WLAMR       REAL                C                REFS        60       132       135       169   DEFINED       130       141
                                                         160       191
  632  WLQ         REAL                C                REFS        44       139
  627  WLQD        REAL                C                REFS        43       135       138   DEFINED       184       136       158
                                                         192
  642  WLQS        REAL                C                REFS        48       143       145
  637  WLQSD       REAL                C                REFS        47       145   DEFINED       143       159       194
  636  WLR         REAL                C                REFS        46       139
  633  WLRD        REAL                C                REFS        45       137       139   DEFINED       135       137       170
                                                         193
  646  WLRS        REAL                C                REFS        50       144       146
  643  WLRSD       REAL                C                REFS        49       145   DEFINED       144       171       195
  712  WL2         REAL                C                REFS        25       145       146
 3312  WP          REAL                C                REFS        38       176       177
 3316  WQ          REAL                C                REFS        39       175       177
  412  WQP         REAL                                 REFS       140       143       186   DEFINED       181       138       145
                                                         157
 3322  WR          REAL                C                REFS        48       175       177
  413  WRP         REAL                                 REFS       141       144       187   DEFINED       182       139       146
                                                         169
  710  WSL         REAL                C                REFS        23       133       138       139
  711  WSN         REAL                C                REFS        24       142       143       144
  665  WY          REAL                C                REFS        64       185   DEFINED       177
  664  WZ          REAL                C                REFS        63       187   DEFINED       176

FILE NAMES          MODE
      TAPE6         FMT                      WRITES       124       153       165

EXTERNALS           TYPE    ARGS        REFERENCES
      ATAND         REAL      2              95        96
      COSD          REAL      1              72        74
      QQ                      0             119
      SIND          REAL      1              73        75
      SQRT          REAL      1  LIBRARY     87

INLINE FUNCTIONS    TYPE    ARGS         DEF LINE   REFERENCES
      ABS           REAL      1  INTRIN                117       118
      AINT          REAL      1  INTRIN                187
      SIGN          REAL      2  INTRIN                114       115
```

```
STATEMENT LABELS              DEF LINE   REFERENCES
     0 10          INACTIVE     190
   177 12                       156        151
   204 20                       162        150        155
   217 22                       168        163
   224 30                       173        148        162        167
     0 80          INACTIVE     101
   127 81                       126        110        113
   131 82                       129        102        103        120        123
   163 83                       148        133        142
   274 101      FMT               6        124
   306 102      FMT               8        153
   320 103      FMT              10        165
    66 820                      109        104

COMMON BLOCKS    LENGTH      MEMBERS - BIAS NAME(LENGTH)
      C           3830                0 C        (3830)

EQUIV CLASSES    LENGTH      MEMBERS - BIAS NAME(LENGTH)
C     C           3830              10 BY      (1)            11 BZ      (1)           370 RANGE   (1)
                                   371 RXBA    (1)           372 RYBA    (1)           373 RZBA    (1)
                                   402 WLAMQ   (1)           406 WLAMR   (1)           407 WLQD    (1)
                                   410 WLQ     (1)           411 WLRD    (1)           414 WLR     (1)
                                   415 WLQSD   (1)           418 WLQS    (1)           419 WLRSD   (1)
                                   422 WLRS    (1)           423 BTHTGD  (1)           426 BTHTG   (1)
                                   427 BPSIGD  (1)           430 BPSIG   (1)           434 BEPSZ   (1)
                                   435 BEPSY   (1)           436 WZ      (1)           437 WY      (1)
                                   438 BGDEFL  (1)           444 RLOCW   (1)           445 DT      (1)
                                   445 BJB     (1)           447 CFOVZ   (1)           448 CFOVY   (1)
                                   449 GSX     (1)           450 SEPS    (1)           451 SWP     (1)
                                   455 SS      (1)           456 WSL     (1)           457 WSN     (1)
                                   458 WL2     (1)           459 ST      (1)           450 GAGE    (1)
                                   461 TKRZ    (1)           462 TKRY    (1)           463 TRKZY   (1)
                                   464 SDY     (1)           465 SDZ     (1)          1738 WP      (1)
                                  1742 WQ      (1)          1746 WR      (1)          1939 T       (1)

STATISTICS
  PROGRAM LENGTH                4168     273
  CM LABELED COMMON LENGTH     7366B    3830
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      SUBROUTINE S4I                                                    S4        3
C**SEEKER INIT.MODULE                                                   S4        4
      COMMON /C/ C(3830)                                                S4        5
      DIMENSION SIGMA(40),SIGLB(40),SIGUB(40),ITNDX(10),IZ(200),IY(200), S4       6
     * ISNDX(40),IPL(100),UVIS(5)                                       S4        7
C                                                                       S4        8
C**INPUT DATA                                                           S4        9
      EQUIVALENCE (C( 506),CROSS )                                      S4       10
      EQUIVALENCE (C( 519),BLUR  )                                      S4       11
      EQUIVALENCE (C( 523),CKNULL)                                      S4       12
      EQUIVALENCE (C( 524),STOTSW)                                      S4       13
      EQUIVALENCE (C( 525),STOTMX)                                      S4       14
      EQUIVALENCE (C( 526),RDES  )                                      S4       15
      EQUIVALENCE (C( 527),HDES  )                                      S4       16
      EQUIVALENCE (C( 529),RVIS  )                                      S4       17
      EQUIVALENCE (C( 530),CPT   )                                      S4       18
      EQUIVALENCE (C( 531),ETHR  )                                      S4       19
      EQUIVALENCE (C( 532),EDES  )                                      S4       20
      EQUIVALENCE (C( 500),WCZ   ), (C( 502),WF    ), (C( 505),BF    )  S4       21
      EQUIVALENCE (C( 507),CZETA ), (C( 508),CKSWP ), (C( 509),SGBIAS)  S4       22
      EQUIVALENCE (C( 518),WCN   ), (C( 510),WCL   ), (C( 511),SGSTOT)  S4       23
      EQUIVALENCE (C( 539),  GSLIM)                                     S4       24
      EQUIVALENCE (C( 446),DT    )                                      S4       25
      EQUIVALENCE (C( 451),SEPS  )                                      S4       26
      EQUIVALENCE (C( 452),SWP   )                                      S4       27
      EQUIVALENCE (C(0456),CS    )                                      S4       28
      EQUIVALENCE (C(0457),WSL   )                                      S4       29
      EQUIVALENCE (C(0458),WSN   )                                      S4       30
      EQUIVALENCE (C(0459),WL2   )                                      S4       31
C                                                                       S4       32
                                                                        S4       33
      EQUIVALENCE (C( 509),SGBIAS)                                      S4       34
      EQUIVALENCE (C( 535),UVIS  )                                      S4       35
      EQUIVALENCE (C( 536),KUTD  )                                      S4       36
      EQUIVALENCE (C( 529),RVIS  )                                      S4       37
      EQUIVALENCE (C( 521),    TKDB)                                    S4       38
      EQUIVALENCE (C( 446),      DT)                                    S4       39
      EQUIVALENCE (C( 525), STOTMX)                                     S4       40
      EQUIVALENCE (C( 520),    STOT)                                    S4       41
      EQUIVALENCE (C( 539),   GSLIM)                                    S4       42
      EQUIVALENCE (C( 524), STOTSW)                                     S4       43
      EQUIVALENCE (C(11),BY)                                            S4       44
      EQUIVALENCE (C(12),BZ)                                            S4       45
      EQUIVALENCE (C(  17), ROSTOT)                                     S4       46
      EQUIVALENCE (C( 538), INIT)                                       S4       47
      EQUIVALENCE (C( 466),    SDZ)                                     S4       48
      EQUIVALENCE (C( 465),    SDY)                                     S4       49
      EQUIVALENCE (C( 435),  BEPSZ)                                     S4       50
      EQUIVALENCE (C( 436),  BEPSY)                                     S4       51
      EQUIVALENCE (C( 207),VMWTE )                                      S4       52
      EQUIVALENCE(C(0411),WLQ)                                          S4       53
      EQUIVALENCE(C(0415),WLR)                                          S4       54
      EQUIVALENCE (C(0419),WLQS)                                        S4       55
      EQUIVALENCE (C(0423),WLRS)                                        S4       56
      EQUIVALENCE (C(0427),BTHTG)                                       S4       57
      EQUIVALENCE (C(0431),BPSIG)                                       S4       58
      EQUIVALENCE (C(0452),SWP)                                         S4       59
```

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      EQUIVALENCE (C( 453),WLZ   )                                    S4      60
      EQUIVALENCE (C( 487),WLY   )                                    S4      61
      EQUIVALENCE (C( 494),WLZS  )                                    S4      62
      EQUIVALENCE (C( 501),WLYS  )                                    S4      63
      EQUIVALENCE (C(1667),RSLANT)                                    S4      64
      EQUIVALENCE (C(3504),OPTN4 )                                    S4      65
      EQUIVALENCE (C(2961),N)                                         S4      66
      EQUIVALENCE (C(2562),IPL)                                       S4      67
      EQUIVALENCE (C(2662),JERSV )                                    S4      68
      EQUIVALENCE (C(3634), ISNDX), (C(3512), I3512)                  S4      69
      EQUIVALENCE (C(3753),  ITNDX)                                   S4      70
      EQUIVALENCE (C(3721),   ITCT)                                   S4      71
      EQUIVALENCE (C(3514),  SIGMA)                                   S4      72
      EQUIVALENCE (C(3554),  SIGL3)                                   S4      73
      EQUIVALENCE (C(3594),  SIGUB)                                   S4      74
      EQUIVALENCE (C(2011), KSTEP)                                    S4      75
      EQUIVALENCE (C( 371),RANGE), (C(1615),RXE), (C(1623),RZE)       S4      76
C                                                                     S4      77
C**NOMINAL SEEKER INPUT VALUES                                        S4      78
C                                                                     S4      79
      DATA  WSL,  WSN,  WL2,  SWP,   GS,  WCZ,   WF,   BF,GROSS       S4      80
     .  /                                                             S4      81
C                                                                     S4      82
      DATA CZETA,CKSWP,SGBIAS,  WCN,  WCL,SGSTOT, BLUR,CXNULL         S4      83
     .  /                                                             S4      84
C                                                                     S4      85
      DATA STOTSW, STOTMX,  RDES,  WDES,  RVIS,  CPT,   ETHR          S4      86
     .  /                                                             S4      87
C                                                                     S4      88
      DATA EDES,GSLIM/                                                S4      89
C                                                                     S4      90
C                                                                     S4      91
      DATA UVIS /1.,3.,5.,10.,15./                                    S4      92
C                                                                     S4      93
      DO 5 J=1,5                                                      S4      94
      IF(ABS(UVIS(J) - RVIS) .LT. .00001) GO TO 6                     S4      95
    5 CONTINUE                                                        S4      96
    6 JVIS = J                                                        S4      97
      KUTJ = 1                                                        S4      98
      C(17) = 0.                                                      S4      99
      C(18) = 0.                                                      S4     100
      IPL(N)=424                                                      S4     101
      IPL(N+1)=428                                                    S4     102
      IPL(N+2)=408                                                    S4     103
      IPL(N+3)=412                                                    S4     104
      IPL(N+4)=416                                                    S4     105
      IPL(N+5)=420                                                    S4     106
      N=N+6                                                           S4     107
      C(411)=0.                                                       S4     108
      C(415)=0.                                                       S4     109
      C(419)=0.                                                       S4     110
      C(423)=0.                                                       S4     111
      C(460) = 0.                                                     S4     112
       BY=0.                                                          S4     113
      BZ=0.                                                           S4     114
      SDY = 0.                                                        S4     115
      SDZ = 0.                                                        S4     116
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```
      ROSTOT=0.
      C( 209)=-RZE
      C(435)=0.
      C(436)=0.
      INIT=0
      DO 10 I = 1, I3512
      IDO = I
C
C ** MONTECARLO SEEKER DRIFT
      IF(ISNOX(I).EQ.465) CALL MCARLO (DUM, 1, IDO)
      IF(ISNOX(I).EQ.466) CALL MCARLO (DUM, 1, IDO)
C
C MONTE CARLO SEEKER OUTPUT STARTING VALUES
C
      IF(ISNOX(I).EQ.460) CALL MCARLO (DUM, 1, IDO)
      IF(C(460).GT.0.)C(460)=-C(460)
C
C  MONTE CARLO SEEKER POINTING ERROR
C
      IF(ISNOX(I).NE.435.AND.ISNOX(I).NE.436)GO TO 23
      RANGE=SQRT(RXE*RXE+RZE*RZE)
      CALL S4ST
      SMR=STOTMX
      IF(STOT.GT.STOTSW)SMR=0.
      SIGOB(I)=-3.
      SIGOB(I)=+3.
      X=DT*SMR
      IF(ISNOX(I).EQ.435)GO TO 21
      IF(ISNOX(I).EQ.436)GO TO 22
21    CONTINUE
      X = X + ABS(SDZ) * DT
      SIGMA(I)=(X-TKDB)/3.
      IF(X.LE.TKDB)SIGMA(I)=(TKDB+ABS(SDZ)*DT)/3.
      GO TO 20
22    CONTINUE
      X = X + ABS(SDY) * DT
      SIGMA(I)=(X-TKDB )/3.
      IF(X.LE.TKDB)SIGMA(I)=(TKDB+ABS(SDY)*DT)/3.
20    CALL MCARLO(DUM,1,IDO)
23    CONTINUE
C
   10 CONTINUE
      INIT=1
      DO 500 I=1,ITCT
      ITSNOX=I
      IF(ITNOX(I).EQ.456)CALL MCARLO(RNSTRT,4,ITSNOX)
      IF(ITNOX(I).EQ.539)CALL MCARLO(RNSTRT,4,ITSNOX)
500   CONTINUE
      BTHIG = BTHIG + BEPSZ
      BPSIG = BPSIG + BEPSY
      C(13) = -1.
      DERSV = .002
      C( 461) = 0.
      C( 462) = 0.
      C( 463) = 0.
      C( 464) = 0.
      IF(SFTN4 .GT. 1.) GO TO 30
```

```
      C(461) = 1.
      C(462) = 1.
      C(463) = 1.
      C(464) = 1.
   30 CONTINUE
C** SEEKER INIT.
      WLQ = VMWTE/RSLANT*BTHTG + SWP*(BTHTG + BPSIG) + SSBIAS
      WLR = VMWTE/RSLANT*BPSIG + SWP*(-BTHTG + BPSIG)
      WLQS = WLQ
      WLRS = WLR
      IPL(N  ) = 480
      IPL(N+1) = 484
      N = N + 2
      C(483) = 0.
      C(487) = 0.
      IPL(N  ) = 488
      IPL(N+1) = 491
      IPL(N+2) = 495
      IPL(N+3) = 498
      N = N + 4
      C(491) = 0.
      C(494) = 0.
      C(498) = 0.
      C(501) = 0.
      WLZ = WLQ
      WLZS = WLQ
      WLYS = WLR
      WLY  = WLR
      RETURN
      END
```

SUBROUTINE S41   74/74   OPT=1   FTN 4.2+74355   07/07/75 11.06.36.   PAGE   5

CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
139	I	13512	THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.
140	I	13512	THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.
146	I	13512	THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.
147	I	13512	THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.
151	I	13512	THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.
152	I	13512	THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.

```
          SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS      DEF LINE      REFERENCES
   1  S4I              1          200

 VARIABLES       SN  TYPE            RELOCATION
    663  BEPSY       REAL                   C       REFS        49     164
    662  BEPSZ       REAL                   C       REFS        48     163
    770  BF          REAL                   C       REFS        19   DEFINED      78
   1006  BLJR        REAL                   C       REFS         9   DEFINED      81
    656  BPSIG       REAL                   C       REFS        56     164       178     2*179   DEFINED     164
    652  ETHTG       REAL                   C       REFS        55     163     2*178      179    DEFINED     163
     12  BY          REAL                   C       REFS        42   DEFINED     111
     13  BZ          REAL                   C       REFS        43   DEFINED     112
      0  C           REAL         ARRAY     C       REFS         3       9         9       10        11       12       13
                                                      14        15      16        17       18      3*19     3*20     3*21
                                                      22        23      24        25       26        27       28       29
                                                      32        33      34        35       36        37       38       39
                                                      40        41      42        43       44        45       46       47
                                                      48        49      50        51       52        53       54       55
                                                      56        57      58        59       60        61       62       63
                                                      64        65      65      2*67       66        69       70       71
                                                      72        73    3*74     2*130   DEFINED       97       98      106
                                                     107       108     109       110      116       117      118      130
                                                     165       167     169       159      170       172      173      174
                                                     175       185     186       132      193       194      195
   1012  CKNULL      REAL                   C       REFS        10   DEFINED      31
    773  CKSMP       REAL                   C       REFS        20   DEFINED      81
   1021  CPT         REAL                   C       REFS        16   DEFINED      84
    771  CROSS       REAL                   C       REFS         8   DEFINED      78
    772  CZETA       REAL                   C       REFS        20   DEFINED      31
   5145  DERSV       REAL                   C       REFS        66   DEFINED     166
    675  DT          REAL                   C       REFS        23      37       141      145       147      150      152
    263  DUM         REAL                           REFS       124     125       129      153
   1023  EDES        REAL                   C       REFS        18   DEFINED      87
   1022  ETHR        REAL                   C       REFS        17   DEFINED      84
    707  GS          REAL                   C       REFS        26   DEFINED      70
   1032  GSLIM       REAL                   C       REFS        22      40    DEFINED       87
   1016  HDES        REAL                   C       REFS        14   DEFINED      34
    261  I           INTEGER                        REFS       121     124       125      129     2*134      139      140
                                                     142       143     145       147      151       152      159      160
                                                     161    DEFINED    120       158
    262  IDO         INTEGER                        REFS       124     125       129      153    DEFINED     121
   1031  INIT        INTEGER                C       REFS        45   DEFINED     119      157
   5001  IPL         INTEGER      ARRAY     C       REFS         4      65    DEFINED       99       100      101      102
                                                     103       104     182       133      187       188      189      190
   7061  ISNOX       INTEGER      ARRAY     C       REFS         4      67       124      125       129    2*134      142
                                                     143
   7210  ITST        INTEGER                C       REFS        69     159
   7250  ITNOX       INTEGER      ARRAY     C       REFS         4      68       160      161
    266  ITSNOX      INTEGER                        REFS       160     161    DEFINED      159
    600  IY          INTEGER      *UNDEF            REFS         4
    270  IZ          INTEGER      *UNDEF            REFS         4
   5607  I3512       INTEGER                C       REFS        67     120
    260  J           INTEGER                        REFS        93      95    DEFINED       92
   1026  JVIS        INTEGER                C       REFS        33   DEFINED      95
   3732  KSTEP       INTEGER                C       REFS        73
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      SUBROUTINE S4I          74/74    OPT=1                           FTN 4.2+74355       07/07/75  11.06.36.        PAGE     7

 VARIABLES        SN  TYPE              RELOCATION
    1027  KUTO        INTEGER              C             REFS          34   DEFINED        96
    3000  N           INTEGER              C             REFS          64        93       100       101       102       103       104
                                                          105         182       183       184       187       188       189       190
                                                          191     DEFINED       185       184       191
    3657  CPTN4       REAL                 C             REFS          63       171
     562  RANGE       REAL                 C             REFS          74   DEFINED       135
    1015  RDES        REAL                 C             REFS          13   DEFINED        94
      20  RDSTOT      REAL                 C             REFS          44   DEFINED       115
     267  RNSTRT      REAL                               REFS         160       161
    3202  RSLANT      REAL                 C             REFS          62       178       179
    1020  RVIS        REAL                 C             REFS          15        35        93   DEFINED        84
    3116  RXE         REAL                 C             REFS          74     2*135
    3126  RZE         REAL                 C             REFS          74       115     2*135
     720  SDY         REAL                 C             REFS          47       150       152   DEFINED       113
     721  SDZ         REAL                 C             REFS          46       145       147   DEFINED       114
     702  SEPS        REAL                 C             REFS          24
     774  SGBIAS      REAL                 C             REFS          20        32       178   DEFINED        81
     776  SGSTOT      REAL                 C             REFS          21   DEFINED        81
    3741  SISLB       REAL       ARRAY     C             REFS           4        70   DEFINED       139
    3671  SIGMA       REAL       ARRAY     C             REFS           4        70   DEFINED       146       147       151       152
    7011  SISUB       REAL       ARRAY     C             REFS           4        72   DEFINED       140
     264  SMR         REAL                               REFS         141   DEFINED       137       138
    1007  STOT        REAL                 C             REFS          39       133
    1014  STOTMX      REAL                 C             REFS          12        38       137   DEFINED        84
    1013  STOTSW      REAL                 C             REFS          11        41       138   DEFINED        84
     703  SWP         REAL                 C             REFS          25        57       178       179   DEFINED        78
    1010  TKOB        REAL                 C             REFS          36       146     2*147       151     2*152
    1110  UVIS        REAL       ARRAY                   REFS           4        93   DEFINED        90
     316  VMATE       REAL                 C             REFS          50       178       179
     775  WCL         REAL                 C             REFS          21   DEFINED        81
    1005  WCN         REAL                 C             REFS          21   DEFINED        81
     763  WCZ         REAL                 C             REFS          19   DEFINED        78
     765  WF          REAL                 C             REFS          19   DEFINED        78
     632  WLQ         REAL                 C             REFS          51       180       196       197   DEFINED       178
     642  WLQS        REAL                 C             REFS          53   DEFINED       180
     636  WLR         REAL                 C             REFS          52       181       198       199   DEFINED       179
     646  WLRS        REAL                 C             REFS          54   DEFINED       181
     746  WLY         REAL                 C             REFS          59   DEFINED       199
     764  WLYS        REAL                 C             REFS          61   DEFINED       198
     742  WLZ         REAL                 C             REFS          58   DEFINED       196
     755  WLZS        REAL                 C             REFS          60   DEFINED       197
     712  WL2         REAL                 C             REFS          29   DEFINED        78
     710  WSL         REAL                 C             REFS          27   DEFINED        78
     711  WSN         REAL                 C             REFS          28   DEFINED        78
     265  X           REAL                               REFS         145       146       147       150       151       152
                                                      DEFINED         141       145       150

 EXTERNALS            TYPE    ARGS        REFERENCES
        MCARLO                 3              124       125       129       153       160       161
        SQRT          REAL     1 LIBRARY      135
        S4ST                   0              136

 INLINE FUNCTIONS     TYPE    ARGS        DEF LINE   REFERENCES
        ABS           REAL     1  INTRIN              93       145       147       150       152
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STATEMENT LABELS                 DEF LINE   REFERENCES
     0  5                           94         92
    13  6                           95         93
     0  10                         156        120
   140  20                         153        148
   111  21                         144        142
   125  22                         149        143
   142  23                         154        134
   201  30                         176        171
     0  500                        162        158

LOOPS  LABEL    INDEX    FROM-TO    LENGTH    PROPERTIES
    0  5        * J      92 94         58       INSTACK     EXITS
   42  10       * I      120 156     1038                   EXT REFS
  147  500      * I      158 162      148                   EXT REFS

COMMON BLOCKS   LENGTH    MEMBERS - BIAS NAME(LENGTH)
        C        3830              0 C         (3830)

EQUIV CLASSES   LENGTH    MEMBERS - BIAS NAME(LENGTH)
C       C        3830         10 BY      (1)        11 BZ      (1)        16 RDSTOT (1)
                             206 VMWTE   (1)       370 RANGE   (1)       410 WLQ    (1)
                             414 WLR     (1)       418 WLQS    (1)       422 WLRS   (1)
                             426 BTHTG   (1)       430 BPSIG   (1)       434 BEPSZ  (1)
                             435 BEPSY   (1)       445 DT      (1)       450 SEPS   (1)
                             451 SWP     (1)       455 GS      (1)       456 WSL    (1)
                             457 WSN     (1)       458 WL2     (1)       454 SDY    (1)
                             465 S3Z     (1)       482 WLZ     (1)       496 WLY    (1)
                             493 WLZS    (1)       499 WCZ     (1)       500 WLYS   (1)
                             501 WF      (1)       504 BF      (1)       505 CROSS  (1)
                             506 CZETA   (1)       507 CKSWP   (1)       508 SGBIAS (1)
                             509 WDL     (1)       510 SGSTOT  (1)       517 WGN    (1)
                             518 BLUR    (1)       519 STOT    (1)       520 TKDB   (1)
                             522 CKNULL  (1)       523 STOTSW  (1)       524 STOTMK (1)
                             525 RDES    (1)       526 HDES    (1)       528 RVIS   (1)
                             529 CPT     (1)       530 ETHR    (1)       531 EDES   (1)
                             534 JVIS    (1)       535 KUTD    (1)       537 INIT   (1)
                             538 SSLIM   (1)      1614 RXE     (1)      1622 RZE    (1)
                            1666 RSLANT  (1)      2010 KSTEP   (1)      2550 N      (1)
                            2561 IPL     (100)    2661 DERSW   (1)      3503 OPTN4  (1)
                            3511 I3512   (1)      3513 SIGMA   (40)     3553 SIGLB  (40)
                            3593 SIGUB   (40)     3633 ISNDX   (40)     3720 ITCT   (1)
                            3752 ITNDX   (10)

STATISTICS
  PROGRAM LENGTH              11153     589
  CM LABELED COMMON LENGTH    73660    3830
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      SUBROUTINE S4                                                    S4     204
C** TRI-SERVICE SEEKER MODULE                                          S4     205
C                                                                      S4     206
      COMMON /C/ C(3830)                                               S4     207
      EQUIVALENCE (C(2000),T      )                                    S4     208
C                                                                      S4     209
C**INPUT DATA                                                          S4     210
      EQUIVALENCE (C( 506),CROSS )                                     S4     211
      EQUIVALENCE (C( 519),BLUR  )                                     S4     212
      EQUIVALENCE (C( 523),CKNULL)                                     S4     213
      EQUIVALENCE (C( 524),STOTSM)                                     S4     214
      EQUIVALENCE (C( 525),STOTMX)                                     S4     215
      EQUIVALENCE (C( 526),RDES  )                                     S4     216
      EQUIVALENCE (C( 527),HDES  )                                     S4     217
      EQUIVALENCE (C( 529),RVIS  )                                     S4     218
      EQUIVALENCE (C( 530),CPT   )                                     S4     219
      EQUIVALENCE (C( 531),ETHR  )                                     S4     220
      EQUIVALENCE (C( 532),EDES  )                                     S4     221
      EQUIVALENCE (C( 500),WCZ   ), (C( 502),WF    ), (C( 505),BF    ) S4     222
      EQUIVALENCE (C( 507),CZETA ), (C( 508),CKSWP ), (C( 509),SSBIAS) S4     223
      EQUIVALENCE (C( 518),WCN   ), (C( 510),WCL   ), (C( 511),SSSTOT) S4     224
      EQUIVALENCE (C( 539),  GSLIM)                                    S4     225
      EQUIVALENCE (C( 446),DT    )                                     S4     226
      EQUIVALENCE (C( 451),SEPS  )                                     S4     227
      EQUIVALENCE (C( 452),SWP   )                                     S4     228
      EQUIVALENCE (C(0456),GS    )                                     S4     229
      EQUIVALENCE (C(0457),WSL   )                                     S4     230
      EQUIVALENCE (C(0458),WSN   )                                     S4     231
      EQUIVALENCE (C(0459),WL2   )                                     S4     232
C                                                                      S4     233
C**INPUTS FROM OTHER MODULES                                           S4     234
      DIMENSION ITNDX(10)                                              S4     235
      EQUIVALENCE (C(3753),  ITNDX)                                    S4     236
      EQUIVALENCE (C(3721),   ITCT)                                    S4     237
      EQUIVALENCE (C( 538),  INIT)                                     S4     238
      EQUIVALENCE (C( 460),ST    )                                     S4     239
      EQUIVALENCE (C( 465),    SDY)                                    S4     240
      EQUIVALENCE (C( 466),    SDZ)                                    S4     241
      EQUIVALENCE (C(0371),RANGE )                                     S4     242
      EQUIVALENCE (C(0372),RX3A  )                                     S4     243
      EQUIVALENCE (C(0373),RY3A  )                                     S4     244
      EQUIVALENCE (C(0374),RZ3A  )                                     S4     245
      EQUIVALENCE (C(1739),WP    )                                     S4     246
      EQUIVALENCE (C(1743),WQ    )                                     S4     247
      EQUIVALENCE (C(1747),WR    )                                     S4     248
      EQUIVALENCE (C( 209),RH    )                                     S4     249
      EQUIVALENCE (C(1623),RZE   )                                     S4     250
      EQUIVALENCE (C(1619),RYE   )                                     S4     251
      EQUIVALENCE (C(1615),RXE   )                                     S4     252
      EQUIVALENCE (C(3511),RANSTT)                                     S4     253
      EQUIVALENCE (C(  17),RDSTOT)                                     S4     254
C                                                                      S4     255
C**STATE VARIABLE OUTPUTS                                              S4     256
      EQUIVALENCE (C(0408),WLID  )                                     S4     257
      EQUIVALENCE (C(0411),WLI   )                                     S4     258
      EQUIVALENCE (C(0412),WLRD  )                                     S4     259
      EQUIVALENCE (C(0415),WLR   )                                     S4     260
```

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      EQUIVALENCE (C(0418),WLQSD )
      EQUIVALENCE (C(0419),WLQS  )
      EQUIVALENCE (C(0420),WLRSD )
      EQUIVALENCE (C(0423),WLRS  )
      EQUIVALENCE (C(0424),BTHTGD)
      EQUIVALENCE (C(0427),BTHTG )
      EQUIVALENCE (C(0428),BPSIGD)
      EQUIVALENCE (C(0431),BPSIG )
      EQUIVALENCE (C( 480),WLZD  )
      EQUIVALENCE (C( 483),WLZ   )
      EQUIVALENCE (C( 484),WLYD  )
      EQUIVALENCE (C( 487),WLY   )
      EQUIVALENCE (C( 488),WLZSDD)
      EQUIVALENCE (C( 491),WLZSD )
      EQUIVALENCE (C( 494),WLZS  )
      EQUIVALENCE (C( 495),WLYSDD)
      EQUIVALENCE (C( 498),WLYSD )
      EQUIVALENCE (C( 501),WLYS  )
C
C** OTHER OUTPUTS
      EQUIVALENCE (C( 433),WLAMQ )
      EQUIVALENCE (C( 434),WLAMR )
      EQUIVALENCE (C(0435),BEPSZ )
      EQUIVALENCE (C(0436),BEPSY )
      EQUIVALENCE (C(0437),WZ    )
      EQUIVALENCE (C(0438),WY    )
      EQUIVALENCE (C(  11),BY    ), (C(  12),BZ    )
      EQUIVALENCE (C( 403),WLAMZ )
      EQUIVALENCE (C( 407),WLAMY )
      EQUIVALENCE (C( 503),WQP   )
      EQUIVALENCE (C( 504),WRP   )
      EQUIVALENCE (C( 520),STOT  )
      EQUIVALENCE (C( 521),TKDB  )
      EQUIVALENCE (C( 522),BNULL2)
      EQUIVALENCE (C( 535),JVIS  )
      EQUIVALENCE (C( 536),KUTD  )
C
C** DATA FOR THE CALCULATION OF SIGNAL-TO-THRESHOLD RATIO
C     AS A FUNCTION OF DESIGNATOR
C     LOCATION - RDES,HDES,YDES IN FEET
C     VISIBILITY - RVIS IN STATUTE MILES
C             (1.,3.,5.,10.,15.)
C        TARGET REFLECTIVITY - CPT
C        INCLUDES ANGLE BETWEEN DESIGNATOR LOS
C        AND NORMAL TO TARGET PLANE
C        DETECTOR THRESHOLD ENERGY  -ETHR IN JOULES/KM**2
C        DESIGNATOR LASER ENERGY - EDES IN JOULES
C        (ANGLE BETWEEN SEEKER LOS AND NORMAL TO TARGET PLANE
C        ASSUMING LAMBERTIAN REFLECTANCE - BALPDS)
C
C
      DIMENSION UGAMZ(5), UH(10), UGAM(10,5)
      DATA PI/3.141593/
C
C  ATMOSPHERIC COEFFICIENTS FOR SEA LEVEL (H = 0. )
C
      DATA UGAMZ /.4922,.4314,.3707,.2188,.06689/
```

```
      C                                                                  S4   318
      C  ATMOSPHERIC COEFFICIENTS AS A FUNCTION OF ALTITUDE (UH)          S4   319
      C                                                                  S4   320
         DATA UH /0.,300.,500.,1000.,2000.,5000.,6560.,10000.,           S4   321
        *        20000.,33000./                                          S4   322
      C                                                                  S4   323
         DATA UGAM /                                                     S4   324
        1  0.,.04216,.06735,.1254,.2180,.3697,.4049,.4445,.4673,.4762,   S4   325
        3  0.,.03696,.05907,.1101,.1914,.3255,.3568,.3921,.4134,.4222,   S4   326
        5  0.,.03176,.05079,.09472,.1649,.2813,.3086,.3398,.3594,.3682,  S4   327
        *  0.,.01876,.03010,.05631,.09863,.1709,.1883,.2080,.2245,.2333, S4   328
        *  0.,.00576,.00940,.0179,.03235,.06054,.06797,.07733,.08962,    S4   329
        *      .09844/                                                   S4   330
         IF(SGSTOT.GT.0.)CALL NORM(RDSTOT,-3.,3.,0.,SGSTOT,RANSTT)       S4   331
         UCT = COSD(BTHTG)                                               S4   332
         UST = SIND(BTHTG)                                               S4   333
         UCP = COSD(BPSIG)                                               S4   334
         USP = SIND(BPSIG)                                               S4   335
         UB11 = UCT*UCP                                                  S4   336
         UB12 = UCT*USP                                                  S4   337
         UB13 =-UST                                                      S4   338
         UB21 =-USP                                                      S4   339
         UB22 = UCP                                                      S4   340
         UB23 = 0.                                                       S4   341
         UB31 = UST*UCP                                                  S4   342
         UB32 = UST*USP                                                  S4   343
         UB33 = UCT                                                      S4   344
      C                                                                  S4   345
      C**TRANSFORM LOS FROM BODY TO GIMBAL AXES                          S4   346
         RXG = UB11*RXBA+UB12*RYBA+UB13*RZBA                             S4   347
         RYG = UB21*RXBA+UB22*RYBA+UB23*RZBA                             S4   348
         RZG = UB31*RXBA+UB32*RYBA+UB33*RZBA                             S4   349
      C                                                                  S4   350
      C**LOS ERRORS IN PLATFORM COORDINATES                              S4   351
         BEPSZ = ATAND(-RZG,RXG)                                         S4   352
         BEPSY = ATAND( RYG,RXG)                                         S4   353
         BEPSZ = BEPSZ - SEPS * BTHTS + BF * SIN(WF*T)                   S4   354
         BEPSY = BEPSY - SEPS * BPSIS + BF * COS(WF*T)                   S4   355
      80 CONTINUE                                                        S4   356
         IF(C(1976).LE.0.) GO TO 82                                      S4   357
         IF(T.LT.(ST-.000001)) GO TO 82                                  S4   358
         IF(C(13).LE.0.) GO TO 820                                       S4   359
         C(13) = -1.                                                     S4   360
         ST = T                                                          S4   361
         C(2664) = DT / AINT(DT / C(2764))                               S4   362
     820 CONTINUE                                                        S4   363
         ST = ST + DT                                                    S4   364
      C                                                                  S4   365
      C** SIGNAL-TO-THRESHOLD RATIO FOR LASER DETECTOR                   S4   366
         ENTRY S4ST                                                      S4   367
         J = JVIS                                                        S4   368
         UCOSA = -RXE/RANGE                                              S4   369
      C** DESIGNATOR TRANSMISSION                                        S4   370
         IF(KUTD .EQ. 0) GO TO 16                                        S4   371
         KUTD = 0                                                        S4   372
         IF(HDES .GT. 0.) GO TO 14                                       S4   373
         UTD = EXP (-UGAMZ(J) * RDES/3281.)                              S4   374
```

```
      GO TO 18
   14 F = 0.
      UGAMD = FINTP1(HDES,UH,UGAM(1,J),10,F,XL)
      UTD = EXP (-UGAMD * RDES/HDES)
C** SEEKER TRANSMISSION
   16 IF(RH .GT. 0.) GO TO 18
      UTS = EXP (-UGAMZ(J) * RANGE/3281.)
       GO TO 20
   18 F = 0.
      UGAMS = FINTP1(R4,UH,JGAM(1,J),10,F,XL)
      UTS = EXP(-UGAMS * RANGE/RH)
C** S/T RATIO
   20 STOT = (EDES * CPT * JCOSA * UTD * UTS) /
     1          (PI * ETHR * (RANGE/3281.)**2)
C
C     PULSE-TO-PULSE AMPLITUDE VARIATIONS
C     NORMAL DISTRIBUTION(1 SIGMA  0 TO 6)
C
      STOT = STOT * 10.**(RDSTOT/10.)
      BLUR2 = BLUR/2.0
      IF(STOT .LE. 0.) GO TO 22
      TKDB = BLUR/(2. * STOT)
      BNULL = BLUR/(CKNULL * STOT)
      GO TO 24
   22 TKDB = BLUR2
      BNULL = BLUR
   24 BNULL2 = BNULL/2.
      IF(INIT.EQ.0)RETURN
C
C** PITCH CHANNEL
C
      BZ = SIGN(1.,BEPSZ)
      IF(ABS(BEPSZ) .GT. TKDB) GO TO 100
C** DEADZONE
      BZ = 0.
      GO TO 200
  100 IF(BNULL .GT. BLUR) GO TO 200
      IF(ABS(BEPSZ) .GT. BLUR2) GO TO 200
      IF(ABS(BEPSZ) .GT. BNULL2) GO TO 110
C** SMALL SIGNAL BANG-BANG
      BZ = SIGN((BNULL/BLUR),BEPSZ)          ,
      GO TO 200
C** LINEAR
  110 BZ = BEPSZ/BLUR2
C
C** YAW CHANNEL
C
  200 BY = SIGN(1.,BEPSY)
      IF(ABS(BEPSY) .GT. TKDB) GO TO 210
C** DEADZONE
      BY = 0.
      GO TO 32
  210 IF(BNULL .GT. BLUR) GO TO 32
      IF(ABS(BEPSY) .GT. BLUR2) GO TO 32
      IF(ABS(BEPSY) .GT. BNULL2) GO TO 220
C** SMALL SIGNAL BANG-BANG
      BY = SIGN((BNULL/BLUR),BEPSY)
```

```
      GO TO 32
C** LINEAR
  220 BY = BEPSY/BLUR2
   32 CONTINUE
C
C     SIGNAL PROCESSING GAIN VARIATIONS
C
      DO 13 I=1,ITCT
C***RANDOMIZE SEEKER OUTPUT GAIN GS--C(456)-- AND/OR SEEKER OUTPUT
C**LIMIT GSLIM--C(539)--
      IOO=I
      IF(ITNOX(I).EQ.456)CALL MCARLO(DUM,2,IOO)
      IF(ITNOX(I).EQ.539)CALL MCARLO(DUM,2,IOO)
13    CONTINUE
      BZ=GS*BZ
      BY=GS*BY
      IF(ABS(BZ).GT.GSLIM)BZ=SIGN(GSLIM,BZ)
      IF(ABS(BY).GT.GSLIM)BY=SIGN(GSLIM,BY)
C
C
C** LIMIT SWITCH ON S/T RATIO
   70 IF(STOT .GT. STOTSW) GO TO 40
      IF(ABS(BZ) .GT. STOTMX) BZ = SIGN(STOTMX,BZ)
      IF(ABS(BY) .GT. STOTMX) BY = SIGN(STOTMX,BY)
   40 CONTINUE
C
      WLAMQ = BZ
      WQF = WLAMQ
      WLAMR = BY
      WRF   = WLAMR
   82 CONTINUE
C
C** LEAD INTEGRAL COMPENSATION
C           WSL = 0.   GAIN GS ONLY
C           WSL .NE. 0.  GS * (S/WSL + 1)/S
C
      IF(WSL .LE. 0.) GO TO 83
      WLQD = BZ
      WLRD = BY
      IF(STOT .GT. STOTSW) WLRD = 0.
      IF(STOT .GT. STOTSW) WLQD = 0.
      WQPPP = WLQD/WSL + WLQ
      WRPPP = WLRD/WSL + WLR
      WLAMQD = WQPPP
      WLAMRD = WRPPP
C
C** PLATFORM COMPENSATION    (S/WL2 + 1) / (S/WSN + 1)
C
      IF(WSN .LE. 0.) GO TO 83
      WLQSD = WSN * (WQPPP - WLQS)
      WLRSD = WSN * (WRPPP - WLRS)
      WQPPP = WLQSD  /WL2 + WLQS
      WRPPP = WLRSD  /WL2 + WLRS
      IF(STOT .GT. STOTSW) GO TO 83
      WLAMQ = WLAMQD
      WLAMR = WLAMRD
      WQP = WQPPP
```

```
      WRP = WRPPP
   53 CONTINUE
C
C** SPRING TERM COMPENSATION
C
      WLAMQP = WLAMQ
      WLAMRP = WLAMR
C
C** GUIDANCE FILTER 1./ (S/WCN+1)   ((S/WCZ)**2+2*CZETA * S/WCZ+1)
C
      WLAMZ = WLAMQP
      WLAMY = WLAMRP
C  NO GUIDANCE FILTER DURING LINEAR OPERATION
      IF(WCN .LE. 0.) GO TO 90
      IF(STOT .GT. STOTSW) WLAMQP = 0.
      IF(STOT .GT. STOTSW) WLAMRP = 0.
      WLZD = WCN * (WLAMQP - WLZ)
      WLYD = WCN * (WLAMRP - WLY)
      WLAMZZ = WLZD/WCL + WLZ
      WLAMYY = WLYD/WCL + WLY
      IF(WCZ .LE. 0.) GO TO 90
      WLZSDD = WCZ * (WCZ*(WLAMZZ - WLZS) - 2. * WLZSD * CZETA)
      WLYSDD = WCZ * (WCZ*(WLAMYY - WLYS) - 2. * WLYSD * CZETA)
      IF (STOT .GT. STOTSW) GO TO 90
      WLAMZ = WLZS
      WLAMY = WLYS
   90 CONTINUE
C
C** MISSILE RATES IN GIMBAL AXES
C
      WZ = UB31 * WP + UB32 * WQ + UB33 * WR
      WY = UB21 * WP + UB22 * WQ + UB23 * WR
C
C** SPRING TERM(IN-AXIS AND CROSS AXIS) AND CROSS COUPLING
C
      UZK = SWP * (-BTHTG - BPSIG) - CROSS * WRP
      UYK = SWP * (-BPSIG + BTHTG) + CROSS * WQP
      UZK=UZK+SDZ
      UYK=UYK+SDY
C
C** GIMBAL ANGLE DERIVATIVES
C
      BTHTGD = WQP + UZK - WY - SGBIAS
      BPSIGD = WRP + UYK - WZ/UB33
      RETURN
      END
```

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         SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS       DEF LINE      REFERENCES
     1  S4              1
   103  S4ST          164        199        330

 VARIABLES      SN  TYPE              RELOCATION
   663  BEPSY        REAL                  C         REFS          81       152       219       220       225       226       228
                                                      231     DEFINED       150       152
   662  BEPSZ        REAL                  C         REFS          80       151       203       204       209       210       212
                                                      215     DEFINED       149       151
   770  BF           REAL                  C         REFS          19       151       152
  1006  BLJR         REAL                  C         REFS           9       191       193       194       197       200       212
                                                      224         228
   564  BLJR2        REAL                            REFS         196       209       215       225       231
                                                  DEFINED         191
   565  BNJLL        REAL                            REFS         198       209       212       224       228
                                                  DEFINED         194       197
  1011  BNJLL2       REAL                  C         REFS          91       218       226   DEFINED       190
   656  BPSIG        REAL                  C         REFS          65       131       132       152       321       322
   653  BPSIGD       REAL                  C         REFS          64   DEFINED       329
   652  BTHTG        REAL                  C         REFS          63       129       130       151       321       322
   647  BTHTGD       REAL                  C         REFS          62   DEFINED       328
    12  BY           REAL                  C         REFS          84       244     2*246     2*252       257       267
                                                  DEFINED         219       222       220       231       244       246       252
    13  BZ           REAL                  C         REFS          84       243     2*245     2*251       255       266
                                                  DEFINED         203       205       212       215       243       245       251
     0  C            REAL        ARRAY     C         REFS           4         5         8         9        10        11        12
                                                       13          14        15        16        17        18      3*19      3*20
                                                     3*21          22        23        24        25        26        27        28
                                                       29          33        34        35        36        37        38        39
                                                       40          41        42        43        44        45        46        47
                                                       48          49        50        51        54        55        56        57
                                                       58          59        60        61        62        63        64        65
                                                       66          67        68        69        70        71        72        73
                                                       74          75        78        79        80        81        82        83
                                                     2*84          85        86        87        88        89        90        91
                                                       92          93       154       156       159   DEFINED       157       159
  1012  CKNULL       REAL                  C         REFS          10       194
   773  CKSWP        REAL                  C         REFS          20
  1021  CPT          REAL                  C         REFS          16       184
   771  CROSS        REAL                  C         REFS           8       321       322
   772  CZETA        REAL                  C         REFS          20       307       308
   675  DT           REAL                  C         REFS          23     2*159       161
   570  DUM          REAL                            REFS         240       241
  1023  EDES         REAL                  C         REFS          18       184
  1022  ETHR         REAL                  C         REFS          17       184
   557  F            REAL                            REFS         174       181   DEFINED       173       180
   707  GS           REAL                  C         REFS          26       243       244
  1032  GSLIM        REAL                  C         REFS          22     2*245     2*246
  1016  HDES         REAL                  C         REFS          14       170       174       175
   566  I            INTEGER                         REFS         239       240       241   DEFINED       236
   567  IDD          INTEGER                         REFS         240       241   DEFINED       239
  1031  INIT         INTEGER               C         REFS          35       193
  7210  ITOT         INTEGER               C         REFS          34       235
  7250  ITNDX        INTEGER     ARRAY     C         REFS          32        33       240       241
   554  J            INTEGER                         REFS         171       174       178       181   DEFINED       165
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VARIABLES	SN	TYPE		RELOCATION								
1026	JVIS	INTEGER		C	REFS	92	163					
1027	KUTD	INTEGER		C	REFS	93	163	DEFINED	169			
516	PI	REAL			REFS	184	DEFINED	110				
562	RANGE	REAL		C	REFS	39	165	178	182	184		
3666	RANSTT	REAL		C	REFS	50	123					
1015	RDES	REAL		C	REFS	13	171	175				
20	RDSTOT	REAL		C	REFS	51	128	190				
320	RH	REAL		C	REFS	46	177	181	182			
1020	RVIS	REAL		C	REFS	15						
563	RX3A	REAL		C	REFS	40	144	145	146			
3116	RXE	REAL		C	REFS	49	165					
551	RXS	REAL			REFS	149	150	DEFINED	144			
564	RY3A	REAL		C	REFS	41	144	145	146			
3122	RYE	REAL		C	REFS	48						
552	RYS	REAL			REFS	150	DEFINED	145				
565	RZ3A	REAL		C	REFS	42	144	145	146			
3126	RZE	REAL		C	REFS	47						
553	RZS	REAL			REFS	149	DEFINED	146				
720	SDY	REAL		C	REFS	37	324					
721	SDZ	REAL		C	REFS	38	323					
702	SEPS	REAL		C	REFS	24	151	152				
774	SGBIAS	REAL		C	REFS	20	328					
776	SGSTOT	REAL		C	REFS	21	2*128					
713	ST	REAL		C	REFS	36	155	161	DEFINED	158	161	
1007	STOT	REAL		C	REFS	89	190	192	193	194	250	260
					269	282	300	301	309	DEFINED	184	190
1014	STOTMX	REAL		C	REFS	12	2*251	2*252				
1013	STOTSW	REAL		C	REFS	11	250	268	269	282	300	301
					309							
703	SWP	REAL		C	REFS	25	321	322				
3717	T	REAL		C	REFS	5	151	152	155	158		
1010	TKOB	REAL		C	REFS	90	204	220	DEFINED	193	196	
540	UB11	REAL			REFS	144	DEFINED	133				
541	UB12	REAL			REFS	144	DEFINED	134				
542	UB13	REAL			REFS	144	DEFINED	135				
543	UB21	REAL			REFS	145	317	DEFINED	136			
544	UB22	REAL			REFS	145	317	DEFINED	137			
545	UB23	REAL			REFS	145	317	DEFINED	138			
546	UB31	REAL			REFS	146	316	DEFINED	139			
547	UB32	REAL			REFS	146	316	DEFINED	140			
550	UB33	REAL			REFS	146	316	329	DEFINED	141		
555	UCOSA	REAL			REFS	184	DEFINED	166				
536	UCP	REAL			REFS	133	137	139	DEFINED	131		
534	UCT	REAL			REFS	133	134	141	DEFINED	129		
622	UGAM	REAL	ARRAY		REFS	109	174	181	DEFINED	121		
560	UGAMJ	REAL			REFS	175	DEFINED	174				
563	UGAMS	REAL			REFS	182	DEFINED	181				
603	UGAMZ	REAL	ARRAY		REFS	109	171	178	DEFINED	114		
510	UH	REAL	ARRAY		REFS	109	174	181	DEFINED	118		
537	USP	REAL			REFS	134	135	140	DEFINED	132		
535	UST	REAL			REFS	135	139	140	DEFINED	130		
556	UTJ	REAL			REFS	184	DEFINED	171	175			
562	UTS	REAL			REFS	184	DEFINED	178	182			
602	UYK	REAL			REFS	324	323	DEFINED	322	324		
601	UZK	REAL			REFS	323	323	DEFINED	321	323		
775	WCL	REAL		C	REFS	21	304	305				
1005	WDN	REAL		C	REFS	21	243	302	303			

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VARIABLES      SN  TYPE             RELOCATION
  763  WCZ         REAL                  C           REFS      19      306     2*307     2*308
  765  WF          REAL                  C           REFS      19      151      152
  660  WLAM1       REAL                  C           REFS      78      255      291    DEFINED     255      283
  573  WLAMQD      REAL                              REFS     283    DEFINED    272
  575  WLAMQP      REAL                              REFS     296      302    DEFINED     291      308
  601  WLAMR       REAL                  C           REFS      79      253      292    DEFINED     257      284
  574  WLAMRD      REAL                              REFS     284    DEFINED    273
  576  WLAMRP      REAL                              REFS     297      303    DEFINED     292      301
  620  WLAMY       REAL                  C           REFS      86    DEFINED    297       311
  600  WLAMYY      REAL                              REFS     308    DEFINED    305
  622  WLAMZ       REAL                  C           REFS      85    DEFINED    296       310
  577  WLAMZZ      REAL                              REFS     307    DEFINED    304
  632  WL1         REAL                  C           REFS      55      270
  627  WL1D        REAL                  C           REFS      54      270    DEFINED     266      269
  642  WL1S        REAL                  C           REFS      59      279      280
  637  WL1SD       REAL                  C           REFS      58      280    DEFINED     278
  636  WLR         REAL                  C           REFS      57      271
  633  WLRD        REAL                  C           REFS      56      271    DEFINED     267      268
  646  WLRS        REAL                  C           REFS      61      279      281
  643  WLRSD       REAL                  C           REFS      60      281    DEFINED     279
  746  WLY         REAL                  C           REFS      69      303      305
  743  WLYD        REAL                  C           REFS      68      305    DEFINED     303
  764  WLYS        REAL                  C           REFS      75      309      311
  761  WLYSD       REAL                  C           REFS      74      309
  756  WLYSDD      REAL                  C           REFS      73    DEFINED    308
  742  WLZ         REAL                  C           REFS      67      302      304
  737  WLZD        REAL                  C           REFS      66      304    DEFINED     302
  755  WLZS        REAL                  C           REFS      72      307      310
  752  WLZSD       REAL                  C           REFS      71      307
  747  WLZSDD      REAL                  C           REFS      70    DEFINED    307
  712  WL2         REAL                  C           REFS      29      280      281
 5312  WP          REAL                  C           REFS      43      315      317
 5316  WQ          REAL                  C           REFS      44      316      317
  766  WQP         REAL                  C           REFS      87      322      328    DEFINED     256      285
  571  WQPPP       REAL                              REFS     272      279      285    DEFINED     278      280
 5322  WR          REAL                  C           REFS      45      315      317
  767  WRP         REAL                  C           REFS      88      321      329    DEFINED     258      286
  572  WRPPP       REAL                              REFS     273      279      286    DEFINED     271      281
  710  WSL         REAL                  C           REFS      27      265      270      271
  711  WSN         REAL                  C           REFS      28      277      278      279
  565  WY          REAL                  C           REFS      83      323    DEFINED     317
  604  WZ          REAL                  C           REFS      82      323    DEFINED     316
  561  X           REAL                              REFS     174      181

EXTERNALS        TYPE    ARGS         REFERENCES
        ATAND    REAL      2             149       150
        COS      REAL      1  LIBRARY    152
        COSD     REAL      1             129       131
        EXP      REAL      1  LIBRARY    171       175       178       182
        FINTP1   REAL      5             174       181
        MCARLO             3             240       241
        NORM               5             128
        SIN      REAL      1  LIBRARY    151
        SIND     REAL      1             130       132
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        SUBROUTINE S4          74/74    OPT=1                         FTN 4.2+74355       07/07/76  11.06.39.        PAGE   10

  INLINE FUNCTIONS    TYPE    ARGS          DEF LINE   REFERENCES
          ABS         REAL       1  INTRIN             204        209        210        220        225        226        245        246
                                                       251        252
          AINT        REAL       1  INTRIN             159
          SIGN        REAL       2  INTRIN             203        212        213        228        245        246        251        252

  STATEMENT LABELS                     DEF LINE    REFERENCES
      0  13                              242         236
    122  14                              173         170
    133  16                              177         168        172
    141  18                              180         177
    152  20                              184         179
    174  22                              196         192
    177  24                              198         195
    244  32                              232         223        224        225        223
    305  40                              253         250
      0  70           INACTIVE           250
      0  80           INACTIVE           153
    311  82                              259         154        155
    335  83                              287         265        277        282
    421  90                              312         299        306        309
    210  100                             208         204
    221  110                             215         210
    223  200                             219         207        208        209        213
    231  210                             224         220
    242  220                             231         226
    100  620                             160         156

  LOOPS  LABEL     INDEX      FROM-TO      LENGTH      PROPERTIES
    245  13        * I        236 242        148                   EXT REFS

  COMMON BLOCKS    LENGTH     MEMBERS - BIAS NAME(LENGTH)
          C          3830                0 C        (3830)

  EQUIV CLASSES    LENGTH     MEMBERS - BIAS NAME(LENGTH)
  C       C          3830                10 BY       (1)                   11 BZ       (1)                   16 RDSTOT  (1)
                                        208 RH       (1)                  370 RANGE    (1)                  371 RXBA    (1)
                                        372 RYBA     (1)                  373 RZBA     (1)                  402 HLAMZ   (1)
                                        406 HLAMY    (1)                  407 HLQD     (1)                  410 HLQ     (1)
                                        411 HLRD     (1)                  414 HLR      (1)                  415 HLQSD   (1)
                                        418 HLQS     (1)                  419 HLRSD    (1)                  422 HLRS    (1)
                                        423 BTHTGD   (1)                  426 BTHTG    (1)                  427 BPSIGD  (1)
                                        430 BPSIG    (1)                  432 HLAMQ    (1)                  433 HLAMR   (1)
                                        434 BEPSZ    (1)                  435 BEPSY    (1)                  436 HZ      (1)
                                        437 HY       (1)                  445 DT       (1)                  450 SEPS    (1)
                                        451 SWP      (1)                  455 GS       (1)                  456 HSL     (1)
                                        457 HSN      (1)                  458 HL2      (1)                  459 ST      (1)
                                        464 SDY      (1)                  465 SDZ      (1)                  479 HLZD    (1)
                                        482 HLZ      (1)                  483 HLYD     (1)                  486 HLY     (1)
                                        487 HLZSDD   (1)                  490 HLZSD    (1)                  493 HLZS    (1)
                                        494 HLYSDD   (1)                  497 HLYSD    (1)                  499 HCZ     (1)
                                        500 HLYS     (1)                  501 HF       (1)                  502 HQP     (1)
                                        503 HRP      (1)                  504 BF       (1)                  505 CROSS   (1)
                                        506 CZETA    (1)                  507 CKSHP    (1)                  508 SGBIAS  (1)
                                        509 HCL      (1)                  510 SGSTOT   (1)                  517 HCN     (1)
                                        518 BLUR     (1)                  519 STOT     (1)                  520 TKDB    (1)
                                        521 BNULL2   (1)                  522 CKNULL   (1)                  523 STOTSW  (1)
                                        524 STOTMX   (1)                  525 RDES     (1)                  526 HDES    (1)
```

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EQUIV CLASSES   LENGTH      MEMBERS - BIAS NAME(LENGTH)
                                   528 RVIS    (1)             529 OPT     (1)             530 ETHR    (1)
                                   531 EDES    (1)             534 JVIS    (1)             535 KUTJ    (1)
                                   537 INIT    (1)             538 GSLIM   (1)            1614 RXE     (1)
                                  1618 RYE     (1)            1622 RZE     (1)            1738 WP      (1)
                                  1742 W2      (1)            1746 WR      (1)            1999 T       (1)
                                  3510 RANSTT  (1)            3720 ITCT    (1)            3752 ITNDX   (10)

STATISTICS
  PROGRAM LENGTH                7048     452
  CM LABELED COMMON LENGTH     73668    3830
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```
      SUBROUTINE C11                                              C1    2
C**TIGER AUTOPILOT INIT. MODULE                                   C1    3
C**HIGH FREQ. MODEL                                               C1    4
      COMMON /C/ C(3830)                                          C1    5
      DIMENSION IPL(100)                                          C1    6
      DIMENSION ISNOX(40)                                         C1    7
      EQUIVALENCE (C(3634),ISNOX),(C(3512),I3512)                 C1    8
      EQUIVALENCE (C(0848),NMSUM )                                C1    9
      EQUIVALENCE (C(2561),N     )                                C1   10
      EQUIVALENCE (C(2562),IPL   )                                C1   11
      EQUIVALENCE (C(841),USCG)                                   C1   12
      EQUIVALENCE (C(842),USCG)                                   C1   13
      NMSUM = N                                                   C1   14
      IPL(N) = 800                                                C1   15
      IPL(N+1) = 820                                              C1   16
      IPL(N+2) = 824                                              C1   17
      IPL(N+3) = 828                                              C1   18
      IPL(N+4) = 832                                              C1   19
      IPL(N+5) = 836                                              C1   20
      IPL(N+6) = 840                                              C1   21
      IPL(N+7) = 880                                              C1   22
      IPL(N+8) = 884                                              C1   23
      IPL(N+9) = 804                                              C1   24
      IPL(N+10) = 808                                             C1   25
      IPL(N+11) = 812                                             C1   26
      IPL(N+12) = 816                                             C1   27
      IPL(N+13) = 888                                             C1   28
      IPL(N+14) = 892                                             C1   29
      N = N+15                                                    C1   30
      C (803) = 0.                                                C1   31
      C( 823) = 0.                                                C1   32
      C( 827) = 0.                                                C1   33
      C( 831) = 0.                                                C1   34
      C( 835) = 0.                                                C1   35
      C( 839) = 0.                                                C1   36
      C( 843) = 0.                                                C1   37
      C( 883) = 0.                                                C1   38
      C( 887) = 0.                                                C1   39
      C( 807) = 0.                                                C1   40
      C( 815) = 0.                                                C1   41
      C( 811) = 0.                                                C1   42
      C( 819) = 0.                                                C1   43
      C( 891) = 0.                                                C1   44
      C( 895) = 0.                                                C1   45
      C(829)=0.   $   C(830)=0.   $   C(838)=0.   $   C(834)=0.   C1   46
      C(837)=0.   $   C(838)=0.                                   C1   47
C                                                                 C1   48
C     MONTE CARLO PITCH AND YAW RATE GYROS ERRORS                 C1   49
C                                                                 C1   50
      DO 30 I=1,I3512                                             C1   51
      IDO=I                                                       C1   52
      IF(ISNOX(I).EQ.829)CALL MCARLO(DUM,1,IDO)                   C1   53
      IF(ISNOX(I).EQ.830)CALL MCARLO(DUM,1,IDO)                   C1   54
      IF(ISNOX(I).EQ.833)CALL MCARLO(DUM,1,IDO)                   C1   55
      IF(ISNOX(I).EQ.833)CALL RANNUM(0.,RNSTRT,2N)                C1   56
      IF(ISNOX(I).EQ.834)CALL MCARLO(DUM,1,IDO)                   C1   57
      IF(ISNOX(I).EQ.837)CALL MCARLO(DUM,1,IDO)                   C1   58
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      IF(ISNOX(I).EQ.838)CALL MCARLO(DUM,1,IDO)
   30 CONTINUE
      CHIG=360.*RN
      UCCS=COSD(CHIG)
      USCS=SIND(CHIG)
C
C     MONTE CARLO ROLL GYRO ATTITUDE AND DRIFT ERRORS ARE MODELED
C     IN D11
C
      RETURN
      END
```

```
            SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS       DEF LINE       REFERENCES
   1  C1I              1             67

VARIABLES       SN  TYPE              RELOCATION
      0  C          REAL        ARRAY   C          REFS          4        2*7        8          9         10        11        12
                                                DEFINED         30         31        32         33         34        35        36
                                                     37         38         39        40         41         42        43        44
                                                   4*45       2*46
    137  CMIG        REAL                             REFS         61         62   DEFINED         60
    134  DUM         REAL                             REFS         52         53        54         56         57        58
    132  I           INTEGER                          REFS         51         52        53         54         55        56        57
                                                     58    DEFINED         50
    133  IDD         INTEGER                          REFS         52         53        54         56         57        58
                                                DEFINED         51
   5001  IPL         INTEGER    ARRAY   C          REFS          5         10   DEFINED         14         15        16        17
                                                     18         19         20        21         22         23        24        25
                                                     26         27         28
   7061  ISNDX       INTEGER    ARRAY   C          REFS          6          7        52         53         54        55        56
                                                     57         59
   5667  I3512       INTEGER            C          REFS          7         50
   5000  N           INTEGER            C          REFS          9         13        14         15         16        17        18
                                                     19         20         21        22         23         24        25        26
                                                     27         28         29   DEFINED         29
   1517  NHSUM       INTEGER            C          REFS          8    DEFINED        13
    136  RN          REAL                             REFS         55         60
    135  RNSTRT    * REAL                             REFS         55
   1510  UCSG        REAL               C          REFS         11    DEFINED        61
   1511  USSG        REAL               C          REFS         12    DEFINED        62

EXTERNALS          TYPE    ARGS         REFERENCES
      COSD         REAL      1              61
      MCARLO                 3              52         53         54         55         57         58
      RANNUM                 3              55
      SIND         REAL      1              62

STATEMENT LABELS                 DEF LINE    REFERENCES
    0  30                           59          50

LOOPS  LABEL     INDEX        FROM-TO      LENGTH      PROPERTIES
   47  30      * I            50 59         40B                 EXT REFS

COMMON BLOCKS   LENGTH      MEMBERS - BIAS NAME(LENGTH)
 -      C         3830               0 C      (3830)

EQUIV CLASSES   LENGTH      MEMBERS - BIAS NAME(LENGTH)
C       C         3830           840 UCCG    (1)               841 USSG     (1)                847 NHSUM   (1)
                                2560 N       (1)              2561 IPL     (100)              3511 I3512   (1)
                                3633 ISNDX   (40)

STATISTICS
  PROGRAM LENGTH                 140B        96
  CM LABELED COMMON LENGTH     7366B       3830
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      SUBROUTINE C1                                                     C1      70
C**TIGER AUTOPILOT MODULE                                               C1      71
C**HIGH FREQ. MODEL                                                     C1      72
      COMMON /C/ C(3830)                                                C1      73
      DIMENSION BDELTC(4)                                               C1      74
C**INPUT DATA                                                           C1      75
      EQUIVALENCE (C(0550),HLIMO )                                      C1      76
      EQUIVALENCE (C(0551),HLIME )                                      C1      77
      EQUIVALENCE (C(0552),DBIAS )                                      C1      78
      EQUIVALENCE (C(0553),RBIAS )                                      C1      79
      EQUIVALENCE (C(0554),GBIAS )                                      C1      80
      EQUIVALENCE (C(0867),SZ)                                          C1      81
      EQUIVALENCE (C(0555),SY)                                          C1      82
      EQUIVALENCE (C(0861),WPI    )                                     C1      83
      EQUIVALENCE (C(0862),DPI    )                                     C1      84
      EQUIVALENCE (C(0863),TAUZ   )                                     C1      85
      EQUIVALENCE (C(0864),TAUY   )                                     C1      86
      EQUIVALENCE (C(0865),HLIMP )                                      C1      87
      EQUIVALENCE (C(0866),TDY    )                                     C1      88
      EQUIVALENCE (C(0871),WQ1    )                                     C1      89
      EQUIVALENCE (C(0872),DQ1    )                                     C1      90
      EQUIVALENCE (C( 877),TAUL   )                                     C1      91
      EQUIVALENCE (C(3504),OPTN4 )                                      C1      92
C**INPUTS FROM OTHER MODULES                                            C1      93
      EQUIVALENCE (C(0353),BPHI)                                        C1      94
      EQUIVALENCE (C(1736),WPD)                                         C1      95
      EQUIVALENCE (C(1677),ANGY)                                        C1      96
      EQUIVALENCE (C(1678),ANGZ)                                        C1      97
      EQUIVALENCE (C(0829),AKBQ)                                        C1      98
      EQUIVALENCE (C(0830),AKBR)                                        C1      99
      EQUIVALENCE (C(0833),AKPQ)                                        C1     100
      EQUIVALENCE (C(0834),AKPR)                                        C1     101
      EQUIVALENCE (C(0837),AKOAQ)                                       C1     102
      EQUIVALENCE (C(0838),AKOAR)                                       C1     103
      EQUIVALENCE (C(841),UDCG)                                         C1     104
      EQUIVALENCE (C(842),USCG)                                         C1     105
      EQUIVALENCE (C(0403),EZ     )                                     C1     106
      EQUIVALENCE (C(0407),EY     )                                     C1     107
      EQUIVALENCE (C(0464),TRKZY )                                      C1     108
      EQUIVALENCE (C(1743),WQ     )                                     C1     109
      EQUIVALENCE (C(1747),WR     )                                     C1     110
C**INPUTS FROM MAIN PROGRAM                                             C1     111
      EQUIVALENCE (C(2000),T      )                                     C1     112
C** STATE VARIABLE OUTPUTS                                              C1     113
      EQUIVALENCE (C( 800),BPHISD)                                      C1     114
      EQUIVALENCE (C( 803),BPHIS )                                      C1     115
      EQUIVALENCE (C(0820),EODCRD)                                      C1     116
      EQUIVALENCE (C(0823),EODCR )                                      C1     117
      EQUIVALENCE (C(0824),EVNCRD)                                      C1     118
      EQUIVALENCE (C(0827),EVNCR )                                      C1     119
      EQUIVALENCE (C( 828),EZSDD )                                      C1     120
      EQUIVALENCE (C( 831),EZSP   )                                     C1     121
      EQUIVALENCE(C(832),EZSD)                                          C1     122
      EQUIVALENCE (C(835),EZS)                                          C1     123
      EQUIVALENCE (C(836),EYSDD)                                        C1     124
      EQUIVALENCE (C(839),EYSP)                                         C1     125
      EQUIVALENCE (C(840),EYSD)                                         C1     126
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      EQUIVALENCE (C( 843),EYS   )                            C1    127
      EQUIVALENCE (C( 880),EZSSD )                            C1    128
      EQUIVALENCE (C( 883),EZSS  )                            C1    129
      EQUIVALENCE (C( 884),EYSSD )                            C1    130
      EQUIVALENCE (C( 887),EYSS  )                            C1    131
      EQUIVALENCE (C(0804),EZRSDD)                            C1    132
      EQUIVALENCE (C(0807),EZRSP )                            C1    133
      EQUIVALENCE (C(0808),EZRSD )                            C1    134
      EQUIVALENCE (C(0811),EZRS  )                            C1    135
      EQUIVALENCE (C(0812),EYRSDD)                            C1    136
      EQUIVALENCE (C(0815),EYRSP )                            C1    137
      EQUIVALENCE (C(0816),EYRSD )                            C1    138
      EQUIVALENCE (C(0819),EYRS  )                            C1    139
      EQUIVALENCE (C(0888),BPISDD)                            C1    140
      EQUIVALENCE (C(0891),BPISP )                            C1    141
      EQUIVALENCE (C(0892),BPISD )                            C1    142
      EQUIVALENCE (C(0895),BPIS  )                            C1    143
C**OUTPUTS                                                    C1    144
      EQUIVALENCE (C(0356),BDELTC)                            C1    145
C**OTHER OUTPUTS                                              C1    146
      EQUIVALENCE (C(0869),WQC   )                            C1    147
      EQUIVALENCE (C(0870),WRC   )                            C1    148
      EQUIVALENCE (C(0876),EZRR  )                            C1    149
      EQUIVALENCE (C(0868),EYRR  )                            C1    150
      EQUIVALENCE (C(0875),BDELPC)                            C1    151
      DATA WQS,WRS /0.0,0.0/                                  C1    152
C**GUIDANCE SWITCHING                                         C1    153
      IF (T .LT. TDY) GO TO 5                                 C1    154
      IF (TRKZY .GT. 0. .OR. OPTN4 .LT. 2.) GO TO 6           C1    155
    5 EZ = 0.                                                 C1    156
      EY = 0.                                                 C1    157
    6 CONTINUE                                                C1    158
C**GUIDANCE SIGNAL SHAPING                                    C1    159
      EZSD = EZSP                                             C1    160
      EYSD = EYSP                                             C1    161
      EZSDD = TAUZ*(TAUZ*(GZ*EZ - EZS) - 2.*EZSD)             C1    162
      EYSDD = TAUY*(TAUY*(GY*EY - EYS) - 2.*EYSD)             C1    163
      EZSSD = TAUZ*(EZSD/TAUL + EZS - EZSS)                   C1    164
      EYSSD = TAUY*(EYSD/TAUL + EYS - EYSS)                   C1    165
C**GRAVITY AND RATE BIAS                                      C1    166
      WQC = EZSS + GBIAS                                      C1    167
      WRC = EYSS + RBIAS                                      C1    168
      IF (TRKZY.LE.0. .OR. T.LT.TDY .OR. OPTN4.LT.2.)         C1    169
     .   WQC=WQC+QBIAS                                        C1    170
C**RATE GYRO DYNAMICS AND LIMITING                            C1    171
C                                                             C1    172
      ANG=ANGY*UCCG + ANGZ*USCG                               C1    173
      WQERG=AKBQ + AKPQ*ANG + AKOAQ*WPD                       C1    174
      WRERG=AKBR + AKPR*ANG + AKOAR*WPD                       C1    175
C                                                             C1    176
C                                                             C1    177
C RATE GYRO MONTE CARLO ERRORS AKB,AKP,AKOA                   C1    178
      WQS=WQ+WQERG                                            C1    179
      WRS=WR+WRERG                                            C1    180
C                                                             C1    181
      BPH=-BPH1                                               C1    182
      IF (ABS(WQS) .GT. 30.) WQS = SIGN(30., WQS)             C1    183
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      IF (ABS(WRS) .GT. 30.) WRS = SIGN(30., WRS)                        C1        184
      EZRR=(WQS-WQC)-(WRS-WRC)                                           C1        185
      EYPR=(WQS-WQC)+(WRS-WRC)                                           C1        186
C**SUMMATION OF RATE DAMPING AND GUIDANCE SIGNALS AND THEIR DERIVATIVES  C1        187
      EZRSD = EZRSP                                                      C1        188
      EYRSD = EYRSP                                                      C1        189
      EZRSDD = WQ1*(WQ1*(EZRR - EZRS) - 2.*DQ1*EZRSD)                    C1        190
      EYRSDD = WQ1*(WQ1*(EYRR - EYRS) -2.*DQ1*EYRSD)                     C1        191
      EODCRD = 2.8*(EZRSDD + (40.+15.)*EZRSD + (40.*15.)*EZRS)/(40.*15.) C1        192
      EVNCRD = 2.8*(EYRSDD + (40.+15.)*EYRSD + (40.*15.)*EYRS)/(40.*15.) C1        193
      IF(ABS(EODCR).LT.HLIMO) GO TO 30                                   C1        194
      EODCR = SIGN (HLIMO,EODCR)                                         C1        195
   30 IF (ABS(EVNCR).LT.HLIME) GO TO 40                                  C1        196
      EVNCR = SIGN (HLIME, EVNCR)                                        C1        197
   40 CONTINUE                                                           C1        198
C**ROLL SIGNAL SHAPING                                                   C1        199
      BPISD = BPISP                                                      C1        200
      BPISDD = WP1*(WP1*(BP4 - BPIS) - 2.*DP1*BPISD)                     C1        201
      BPHISD = .33*(BPISDD + (60.+12.)*BPISD + (60.*12.)*BPIS)/(60.*12.) C1        202
      IF (ABS(BPHISD) .GT. HLIMP) BPHISD = SIGN(HLIMP, BPHISD)           C1        203
      BDELPC = .1*(BPHISD/.1 + BPHIS)                                    C1        204
C**COMMANDS TO ACTUATORS                                                 C1        205
      BDELTC(1) = EODCR + BDELPC                                         C1        206
      BDELTC(2) = EVNCR + BDELPC                                         C1        207
      BDELTC(3) = EODCR - BDELPC                                         C1        208
      BDELTC(4) = EVNCR - BDELPC                                         C1        209
      RETURN                                                             C1        210
      END                                                                C1        211
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        SUBROUTINE C1          74/74    OPT=1                          FTN 4.2+74355       07/07/75  11.06.46.      PAGE     4

        SYMBOLIC REFERENCE MAP (R=3)

  ENTRY POINTS       DEF LINE       REFERENCES
     1  C1               1            141

  VARIABLES        SN  TYPE                RELOCATION
     1474  AK3Q        REAL                   C          REFS        29       105
     1475  AK3R        REAL                   C          REFS        30       2*106
     1504  AKJAQ       REAL                   C          REFS        33       105
   . 1505  AKJAR       REAL                   C          REFS        34       105
     1500  AKPQ        REAL                   C          REFS        31       105
     1501  AKPR        REAL                   C          REFS        32
      217  ANS         REAL                              REFS       105       105     DEFINED      104
     3214  ANSY        REAL                   C          REFS        27       104
     3215  ANSZ        REAL                   C          REFS        28       104
     1552  BDELPC      REAL                   C          REFS        82       137       138        139       140
                                                      DEFINED       135
     1527  BDELTC      REAL          ARRAY    C          REFS         5        75     DEFINED      137       138       139       140
      222  BPH         REAL                              REFS       132    DEFINED      113
     1442  BPHIS       REAL                   C          REFS        46       135
     1437  BPHISD      REAL                   C          REFS        45       2*134     135      DEFINED      133       134
      540  BPH1        REAL                   C          REFS        25       113
     1576  BPIS        REAL                   C          REFS        74       132       133
     1573  BPISD       REAL                   C          REFS        73       132       133      DEFINED      131
     1567  BPISDD      REAL                   C          REFS        71       133     DEFINED      132
     1572  BPISP       REAL                   C          REFS        72       131
        0  C           REAL          ARRAY    C          REFS         4         7         8          9        10        11        12
                                                           13        14        15        16         17        18        19        20
                                                           21        22        23        25         26        27        28        29
                                                           30        31        32        33         34        35        36        37
                                                           38        39        40        41         43        45        46        47
                                                           48        49        50        51         52        53        54        55
                                                           56        57        58        59         60        61        62        63
                                                           64        65        65        67         68        69        70        71
                                                           72        73        74        76         78        79        80        81
                                                           82
     1535  DP1         REAL                   C          REFS        15       132
     1547  DQ1         REAL                   C          REFS        21       121       122
     1466  EDJCK       REAL                   C          REFS        48       125       126        137       139
                                                      DEFINED       126
     1463  EDJCKD      REAL                   C          REFS        47    DEFINED      123
     1472  EVNCK       REAL                   C          REFS        50       127       128        138       140
                                                      DEFINED       128
     1467  EVNCKD      REAL                   C          REFS        49    DEFINED      124
      625  EY          REAL                   C          REFS        38        94     DEFINED       88
     1543  EYRR        REAL                   C          REFS        81       122     DEFINED      117
     1462  EYRS        REAL                   C          REFS        70       122       124
     1457  EYRSD       REAL                   C          REFS        69       122       124      DEFINED      120
     1453  EYRSDD      REAL                   C          REFS        67       124     DEFINED      122
     1456  EYRSP       REAL                   C          REFS        68       120
     1512  EYS         REAL                   C          REFS        58        94        96
     1507  EYSD        REAL                   C          REFS        57        94        96      DEFINED       92
     1503  EYSDD       REAL                   C          REFS        55    DEFINED       94
     1506  EYSP        REAL                   C          REFS        56        92
     1566  EYSS        REAL                   C          REFS        62        95        99
     1563  EYSSD       REAL                   C          REFS        61    DEFINED       96
      622  EZ          REAL                   C          REFS        37        93     DEFINED       87
```

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     SUBROUTINE C1          74/74    OPT=1                              FTN 4.2+74353       07/07/75  11.06.46.        PAGE     5

VARIABLES       SN  TYPE                RELOCATION
   1353  EZRR        REAL                  C           REFS        60        121     DEFINED      116
   1452  EZRS        REAL                  C           REFS        66        121       123
   1447  EZRSD       REAL                  C           REFS        65        121       123    DEFINED       119
   1443  EZRSDD      REAL                  C           REFS        63        123     DEFINED      121
   1446  EZRSP       REAL                  C           REFS        64        119
   1502  EZS         REAL                  C           REFS        54         93        95
   1477  EZSD        REAL                  C           REFS        53         93        95    DEFINED        91
   1473  EZSDD       REAL                  C           REFS        51      DEFINED      93
   1476  EZSP        REAL                  C           REFS        52         91
   1562  EZSS        REAL                  C           REFS        60         95        98
   1357  EZSSD       REAL                  C           REFS        59      DEFINED      95
   1325  GBIAS       REAL                  C           REFS        11         93
   1326  GY          REAL                  C           REFS        13         94
   1542  GZ          REAL                  C           REFS        12         93
   1522  MLIME       REAL                  C           REFS         8        127       128
   1521  MLIMO       REAL                  C           REFS         7        125       126
   1540  MLIMP       REAL                  C           REFS        18       2*134
   3657  OPTN4       REAL                  C           REFS        23         85       100
   1523  QBIAS       REAL                  C           REFS         9        100
   1524  RBIAS       REAL                  C           REFS        10         93
   3717  T           REAL                  C           REFS        43         85       130
   1554  TAJL        REAL                  C           REFS        22         95        96
   1537  TAJY        REAL                  C           REFS        17        2*94       96
   1536  TAJZ        REAL                  C           REFS        16        2*93       95
   1541  TOY         REAL                  C           REFS        19         85       100
    717  TRKZY       REAL                  C           REFS        39         85       100
   1510  UCSG        REAL                  C           REFS        35        104
   1511  USCG        REAL                  C           REFS        36        104
   3307  WP0         REAL                  C           REFS        26        105       106
   1534  WP1         REAL                  C           REFS        14       2*132
   3316  WQ          REAL                  C           REFS        40        110
   1544  WQC         REAL                  C           REFS        78        100       116       117     DEFINED       98        100
    220  WQERG       REAL                              REFS       110      DEFINED     105
    175  WQS         REAL                              REFS     2*114        115       117    DEFINED        83       110        114
   1546  WQ1         REAL                  C           REFS        20       2*121     2*122
   3322  WR          REAL                  C           REFS        41        111
   1545  WRC         REAL                  C           REFS        79        116       117    DEFINED        99
    221  WRERG       REAL                              REFS       111      DEFINED     106
    176  WRS         REAL                              REFS     2*115        116       117    DEFINED        88       111        115

INLINE FUNCTIONS    TYPE    ARGS         DEF LINE   REFERENCES
         ABS        REAL     1  INTRIN                 114        115        125       127       134
         SIGN       REAL     2  INTRIN                 114        115        125       128       134

STATEMENT LABELS                 DEF LINE    REFERENCES
     10  5                          87          85
     12  6                          89          86
    141  30                        127         125
    145  40                        129         127

COMMON BLOCKS    LENGTH      MEMBERS - BIAS NAME(LENGTH)
         C         3830                 0 C         (3830)

EQUIV CLASSES    LENGTH      MEMBERS - BIAS NAME(LENGTH)
 C       C         3830            352 BPH1    (1)             402 EZ       (1)              436 EY      (1)
                                   463 TRKZY   (1)             799 BPHISD   (1)              832 BPHIS   (1)
                                   903 EZRSDD  (1)             806 EZRSP    (1)              837 EZRSD   (1)
```

```
EQUIV CLASSES   LENGTH     MEMBERS - BIAS NAME(LENGTH)
                              810 EZRS     (1)          811 EYRSDD  (1)          814 EYRSP   (1)
                              815 EYRSD    (1)          818 EYRS    (1)          819 EODCRD  (1)
                              822 EODCR    (1)          823 EVNCRD  (1)          826 EVNCR   (1)
                              827 EZSDD    (1)          828 AKB1    (1)          829 AKBR    (1)
                              830 EZSP     (1)          831 EZSD    (1)          832 AKPQ    (1)
                              833 AKPR     (1)          834 EZS     (1)          835 EYSDD   (1)
                              836 AKOAQ    (1)          837 AKOAR   (1)          838 EYSP    (1)
                              839 EYSD     (1)          840 UCCG    (1)          841 USCG    (1)
                              842 EYS      (1)          849 HLIMO   (1)          850 HLIME   (1)
                              851 QBIAS    (1)          852 RBIAS   (1)          853 GBIAS   (1)
                              854 GY       (1)          855 BDELTC  (4)          858 WP1     (1)
                              861 DP1      (1)          862 TAUZ    (1)          863 TAUY    (1)
                              864 HLIMP    (1)          865 TOY     (1)          866 QZ      (1)
                              867 EYRR     (1)          868 WQC     (1)          869 WRC     (1)
                              870 W21      (1)          871 DQ1     (1)          874 BDELPC  (1)
                              875 EZRR     (1)          876 TAU.    (1)          879 EZSSD   (1)
                              882 EZSS     (1)          883 EYSSD   (1)          885 EYSS    (1)
                              887 BPISDD   (1)          890 BPISP   (1)          891 BPISD   (1)
                              894 BPIS     (1)         1676 ANGY    (1)         1577 ANGZ    (1)
                             1735 WPD      (1)         1742 WQ      (1)         1746 WR      (1)
                             1999 T        (1)         3583 OPTN4   (1)

STATISTICS
  PROGRAM LENGTH                2238      147
  CM LABELED COMMON LENGTH     73666     3830
```

SUBROUTINE C3I   74/74   OPT=1   FTN 4.2+74355   07/07/75 11.06.52.   PAGE   1

```
      SUBROUTINE C3I                                                  C3       2
      COMMON /C/ C(3830)                                              LABC04  24
      IF(C(2664)-0.01 .LT. 1.E-6)GO TO 10                             C3       4
      WRITE(6,20)                                                     C3       5
       C(2664)=0.01                                                   C3       6
   20 FORMAT(* INTEGRATION STEP SIZE LARGER THAN SAMPLE RATE,SET EQUAL C3      7
     CTO SAMPLE RATE*)                                                C3       8
   10 IF(ABS(C(446)-0.01*AINT(C(446)/0.01+1.E-6)).LT.1.E-6)GO TO 30   C3       9
      WRITE(6,40)                                                     C3      10
   40 FORMAT(* PRF IS NOT A MULTIPLE OF THE SAMPLE RATE*)             C3      11
      STOP                                                            C3      12
   30 IF(ABS(0.01-C(2664)*AINT(0.01/C(2664)+1.E-6)).LT.1.E-6)GO TO 50 C3      13
      C(2664)=0.01/AINT(0.01/C(2664)+1.E-6)                           C3      14
      WRITE(6,45)C(2664)                                              C3      15
   45 FORMAT(* INTEGRATION STEPSIZE NOT A MULTIPLE OF SAMPLE RATE*    C3      16
     C* ADJUSTED STEPSIZE IS*,F15.5)                                  C3      17
   50 CONTINUE                                                        C3      18
      C(3462)=0.0                                                     C3      19
      DO 1 I=1,21                                                     C3      20
    1 C(3337+I)=0.0                                                   C3      21
      C(827)=0.                                                       C3      22
      C(831)=0.                                                       C3      23
      RETURN                                                          C3      24
      END                                                             C3      25
```

```
          SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS      DEF LINE       REFERENCES
    1  CSI              1            23

 VARIABLES      SN  TYPE            RELOCATION
     0  C            REAL       ARRAY    C              REFS         2          3        2*8       2*12       13         14
                                                     DEFINED         5         13         18         20        21         22
   114  I            INTEGER                            REFS        20     DEFINED        19

 FILE NAMES        MODE
        TAPE6      FMT                  WRITES           4          9         14

 INLINE FUNCTIONS     TYPE    ARGS          DEF LINE   REFERENCES
        ABS           REAL      1   INTRIN                    8         12
        AINT          REAL      1   INTRIN                    8         12         13

 STATEMENT LABELS             DEF LINE     REFERENCES
     0  1                        20           19
    11  10                        6            3
    50  20           FMT          6            4
    22  30                       12            8
    64  40           FMT         10            9
    76  45           FMT         15           14
    33  50                       17           12

 LOOPS  LABEL     INDEX       FROM-TO       LENGTH      PROPERTIES
    40  1          * I         19 20          33          INSTACK

 COMMON BLOCKS     LENGTH        MEMBERS - BIAS NAME(LENGTH)
        C           3830               0 C       (3830)

 STATISTICS
   PROGRAM LENGTH                 115B         77
   CM LABELED COMMON LENGTH      7366B       3830
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```
      SUBROUTINE C3                                                  C3        26
      DIMENSION BDELTC(4)                                            C3        27
      COMMON /C/ C(3830)                                             LABC04    25
      EQUIVALENCE(C(2664),DER)                                       C3        29
      EQUIVALENCE(C(3462),HOLD)                                      C3        30
      EQUIVALENCE (C( 860),TDY   )                                   C3        31
      EQUIVALENCE (C( 381),GBIAS)                                    C3        32
      EQUIVALENCE (C( 370),HJK)                                      C3        33
      EQUIVALENCE (C( 878),QBIAS)                                    C3        34
      EQUIVALENCE (C( 879),RBIAS)                                    C3        35
      EQUIVALENCE (C( 390),HXX)                                      C3        36
      EQUIVALENCE (C(403),WLAMQ)                                     C3        37
      EQUIVALENCE (C(407),WLAMR)                                     C3        38
      EQUIVALENCE (C( 353),BPH1)                                     C3        39
      EQUIVALENCE (C( 354),BTH2)                                     C3        40
      EQUIVALENCE (C( 355),BPS1)                                     C3        41
      EQUIVALENCE (C( 461),CAGE)                                     C3        42
      EQUIVALENCE (C( 462),TKRZ)                                     C3        43
      EQUIVALENCE (C( 463),TKRY)                                     C3        44
      EQUIVALENCE (C(2000),T   )                                     C3        45
      EQUIVALENCE (C( 827),BLQSS)                                    C3        46
      EQUIVALENCE (C( 831),BLRSS)                                    C3        47
      EQUIVALENCE (C( 880),BXX)                                      C3        48
      EQUIVALENCE (C( 881),BJJ)                                      C3        49
      EQUIVALENCE (C( 882),BKK)                                      C3        50
      EQUIVALENCE (C( 883),BXXSS)                                    C3        51
      EQUIVALENCE (C( 884),BJJSS)                                    C3        52
      EQUIVALENCE (C( 885),BKKSS)                                    C3        53
      EQUIVALENCE (C( 886),BTHTS)                                    C3        54
      EQUIVALENCE (C( 887),BPSIS)                                    C3        55
      EQUIVALENCE (C(856),BDELTC)                                    C3        56
C                                                                    ROLLGYRO  18
C                        ***NOTE***                                  ROLLGYRO  19
C     IF THIS AUTOPILOT IS TO BE USED WITH THE 7 INCH MISSILE,       ROLLGYRO  20
C     BTH2,BPS1,AND BPH1 CALCULATIONS MUST BE RESTORED TO G5.        ROLLGYRO  21
C     DO THIS WITH AN *YANK ROLLGYRO CARD IN AN UPDATE RUN.          ROLLGYRO  22
C                                                                    ROLLGYRO  23
                                                                     C3        57
                                                                     C3        58
      IF(C(1975).LT.0)RETURN                                         C3        59
      HOLD=HOLD-1.01                                                 C3        60
      IF(HOLD.GT.0.0)RETURN                                          C3        61
      HOLD=0.01/DER                                                  C3        62
      CALL   ATD(WLAMQ,1)                                            C3        63
      CALL   ATD(WLAMR,2)                                            C3        64
      CALL MODCON(1,1,WLAMQ,EO)                                      C3        65
      WQC=EO+GBIAS                                                   C3        66
      CALL MODCON(1,2,WLAMR,EO)                                      C3        67
      WRC=EO+RBIAS                                                   C3        68
      IF(TKRZ.GT.0..AND.T.GT.TDY)GO TO 4                             C3        69
      WQC=QBIAS+GBIAS                                                C3        70
      IF(CAGE.GT.0..AND.T.GT.TDY)WQC=WLAMQ+GBIAS                     C3        71
    4 IF(TKRY.GT.0.)GO TO 5                                          C3        72
      WRC=RBIAS                                                      C3        73
      IF(CAGE.GT.0.)WRC=WLAMR                                        C3        74
    5 CONTINUE                                                       C3        75
      BTHTS=-BTH2                                                    C3        76
```

```
            BPSIS=-BPSI                                     C3      77
            BXX=-BPHI                                       C3      78
            CALL  ATD(BXX,3)                                C3      79
            CALL  ATD(BTHTS,4)                              C3      80
            CALL  ATD(BPSIS,5)                              C3      81
            CALL MODCON(2,3,WQC,BLQSS)                      C3      82
            CALL MODCON(2,4,WRC,BLRSS)                      C3      83
            BJJ= BLQSS-BTHTS                                C3      84
            BKK= BLRSS-BPSIS                                C3      85
            CALL QUAN(BJJ,4,4)                              C3      86
            CALL QUAN(BKK,4,4)                              C3      87
            CALL MODCON(4,7,BXX,BXXSS)                      C3      88
            CALL MODCON(3,5,BJJ,BJJSS)                      C3      89
            CALL MODCON(3,6,BKK,BKKSS)                      C3      90
            IF(ABS(BJJSS).GT.HJK)BJJSS=SIGN(HJK,BJJSS)      C3      91
            IF(ABS(BKKSS).GT.HJK)BKKSS=SIGN(HJK,BKKSS)      C3      92
            IF(ABS(BXXSS).GT.HXX)BXXSS=SIGN(HXX,BXXSS)      C3      93
            HX=BXXSS-BJJSS                                  C3      94
            GX=-BXXSS-BJJSS                                 C3      95
            CALL QUAN(HX,4,5)                               C3      96
            CALL QUAN(GX,4,5)                               C3      97
            BDELTC(1)=HX+BKKSS                              C3      98
            BDELTC(2)=HX-BKKSS                              C3      99
            BDELTC(3)=GX+BKKSS                              C3      100
            BDELTC(4)=GX-BKKSS                              C3      101
            DO 16 II=1,4                                    C3      102
         16 CALL  DTA(BDELTC(II),II)                        C3      103
            RETURN                                          C3      104
            END                                             C3      105
```

```
           SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS        DEF LINE      REFERENCES
   1  C3                1            40          42          85

VARIABLES          SN  TYPE            RELOCATION
  1527  BDELTC        REAL         ARRAY   C          REFS       2          31          84     DEFINED       79          80          81
                                                       82
  1560  BJJ           REAL                 C          REFS      24          67          70     DEFINED       65
  1563  BJJSS         REAL                 C          REFS      27          70        2*72        75         76
                                                   DEFINED      72
  1561  BKK           REAL                 C          REFS      25          68          71     DEFINED       66
  1564  BKKSS         REAL                 C          REFS      28          71        2*73        79         80          81          82
                                                   DEFINED      73
  1472  BLJSS         REAL                 C          REFS      21          63          65
  1476  BLRSS         REAL                 C          REFS      22          64          66
   540  BP41          REAL                 C          REFS      14          53
  1566  BPSIS         REAL                 C          REFS      30          62          66     DEFINED       58
   542  BPSI          REAL                 C          REFS      16          58
  1565  BTHTS         REAL                 C          REFS      29          61          65     DEFINED       57
   541  BT42          REAL                 C          REFS      15          57
  1557  BXX           REAL                 C          REFS      23          60          59     DEFINED       59
  1562  BXXSS         REAL                 C          REFS      26          69        2*74        75         76
                                                   DEFINED      74
     0  C             REAL         ARRAY   C          REFS       3           4           5         6          7           8           9
                                                       10       11          12          13        14         15          16          17
                                                       18       19          20          21        22         23          24          25
                                                       26       27          28          29        30         31          40
   714  CASE          REAL                 C          REFS      17          52          55
  3147  DER           REAL                 C          REFS       4          43
   255  EJ            REAL                            REFS      46          47          48        49
  1534  GBIAS         REAL                 C          REFS       7          47          51        52
   261  GX            REAL                            REFS      78          81          82     DEFINED       76
  1545  HJK           REAL                 C          REFS       8        2*72        2*73
  3605  HOLD          REAL                 C          REFS       5          41          42     DEFINED       41          43
   260  HX            REAL                            REFS      77          78          80     DEFINED       75
  1571  HXX           REAL                 C          REFS      11        2*74
   262  II            INTEGER                         REFS    2*84     DEFINED          83
  1555  OBIAS         REAL                 C          REFS       9          51
  1556  RBIAS         REAL                 C          REFS      10          49          54
  3717  T             REAL                 C          REFS      20          50          52
  1533  TOY           REAL                 C          REFS       6          50          52
   713  TKRY          REAL                 C          REFS      19          53
   715  TKRZ          REAL                 C          REFS      18          50
   622  WLAMQ         REAL                 C          REFS      12          44          46        52
   626  WLAMR         REAL                 C          REFS      13          45          48        55
   256  WQC           REAL                            REFS      63     DEFINED          47        51         52
   257  WRC           REAL                            REFS      64     DEFINED          49        54         55

EXTERNALS              TYPE    ARGS         REFERENCES
        ATD                      2              44          45          60          61          62
        ETA                      2              84
        MODCON                   *              46          46          63          64          69         78          71
        QUAN                     3              67          68          77          78
```

```
INLINE FUNCTIONS    TYPE    ARGS          DEF LINE   REFERENCES
      ABS           REAL      1  INTRIN                 72         73         74
      SIGN          REAL      2  INTRIN                 72         73         74

STATEMENT LABELS               DEF LINE    REFERENCES
   35  4                         53          50
   43  5                         56          53
    0  16                        84          83

LOOPS  LABEL    INDEX      FROM-TO     LENGTH     PROPERTIES
  131   16      * II        83 84       6B                    EXT REFS

COMMON BLOCKS   LENGTH      MEMBERS - BIAS NAME(LENGTH)
        C        3830                  0 C      (3830)

EQUIV CLASSES   LENGTH      MEMBERS - BIAS NAME(LENGTH)
C         C      3830              352 BPH1    (1)            353 BT42    (1)            354 BPS1    (1)
                                   402 WLAMQ   (1)            406 WLAMR   (1)            450 CAGE    (1)
                                   461 TKRZ    (1)            462 TKRY    (1)            826 BLOSS   (1)
                                   830 BLRSS   (1)            855 BDELTO  (4)            859 TOY     (1)
                                   860 GBIAS   (1)            869 HJK     (1)            877 QBIAS   (1)
                                   878 RBIAS   (1)            879 BXX     (1)            880 BJJ     (1)
                                   881 BKK     (1)            882 BXXSS   (1)            883 BJJSS   (1)
                                   884 BKKSS   (1)            885 BTHTS   (1)            886 BPSIS   (1)
                                   889 HXX     (1)           1999 T       (1)           2653 DER     (1)
                                  3461 HOLD    (1)

STATISTICS
  PROGRAM LENGTH               2633      179
  CM LABELED COMMON LENGTH    73668     3830
```

```
      SUBROUTINE MODCON(I,J,EI,EO)                                      C3       106
      COMMON /C/ C(3830)                                                LABC04    26
      DIMENSION   AO(4),A1(4),A2(4),A3(4),B1(4),B2(4),33(4)             C3       108
      DIMENSION   X1(7),X2(7),X3(7)                                     C3       109
      EQUIVALENCE (C(3338),X1)                                          C3       110
      EQUIVALENCE (C(3345),X2)                                          C3       111
      EQUIVALENCE (C(3352),X3)                                          C3       112
      EQUIVALENCE (C(3359),AO)                                          C3       113
      EQUIVALENCE (C(3363),A1)                                          C3       114
      EQUIVALENCE (C(3367),A2)                                          C3       115
      EQUIVALENCE (C(3371),A3)                                          C3       116
      EQUIVALENCE (C(3375),31)                                          C3       117
      EQUIVALENCE (C(3379),B2)                                          C3       118
      EQUIVALENCE (C(3383),33)                                          C3       119
C     I IDENTIFIES FILTER                                               C3       120
C      1=GUIDANCE,  2=INTEGRATOR,  3=PITCH/YAW,  4=ROLL                 C3       121
C     J IDENTIFIES PATH                                                 C3       122
C     WLAMQ  1=GUIDANCE,  3=INTEGRATOR                                  C3       123
C     WLAMK  2=GUIDANCE,  4=INTEGRATOR                                  C3       124
C              5=PITCH,   6=YAW,    7=ROLL                              C3       125
      EO=AO(I)*EI                                                       C3       126
      CALL QUAN(EO,4,J)                                                 C3       127
      EO=EO+X3(J)                                                       C3       128
      CALL QUAN(EO,4,J)                                                 C3       129
      X3(J)=A1(I)*EI                                                    C3       130
      CALL QUAN(X3(J),3,J)                                              C3       131
      TEMP=B1(I)*EO                                                     C3       132
      CALL QUAN(TEMP,3,J)                                               C3       133
      X3(J)=X3(J)-TEMP                                                  C3       134
      CALL QUAN(X3(J),3,J)                                              C3       135
      X3(J)=X3(J)+X2(J)                                                 C3       136
      CALL QUAN(X3(J),3,J)                                              C3       137
      X2(J)=A2(I)*EI                                                    C3       138
      CALL QUAN(X2(J),2,J)                                              C3       139
      TEMP=B2(I)*EO                                                     C3       140
      CALL QUAN(TEMP,2,J)                                               C3       141
      X2(J)=X2(J)-TEMP                                                  C3       142
      CALL QUAN(X2(J),2,J)                                              C3       143
      X2(J)=X2(J)+X1(J)                                                 C3       144
      CALL QUAN(X2(J),2,J)                                              C3       145
      IF(I.LT.3)RETURN                                                  C3       146
       X1(J)=A3(I)*EI                                                   C3       147
      CALL QUAN(X1(J),1,J)                                              C3       148
      TEMP=B3(I)*EO                                                     C3       149
      CALL QUAN(TEMP,1,J)                                               C3       150
      X1(J)=X1(J)-TEMP                                                  C3       151
      CALL QUAN(X1(J),1,J)                                              C3       152
      RETURN                                                            C3       153
      END                                                               C3       154
```

```
     SUBROUTINE MODCON      74/74    OPT=1                              FTN 4.2+74355       07/07/75  11.06.55.        PAGE     2

          SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS       DEF LINE       REFERENCES
    3  MODCON          1            41        48

VARIABLES        SN  TYPE            RELOCATION
  3436   A0          REAL      ARRAY    C            REFS       3        3       21
  3442   A1          REAL      ARRAY    C            REFS       3        9       25
  3446   A2          REAL      ARRAY    C            REFS       3       10       33
  3452   A3          REAL      ARRAY    C            REFS       3       11       42
  3456   B1          REAL      ARRAY    C            REFS       3       12       27
  3462   B2          REAL      ARRAY    C            REFS       3       13       35
  3466   B3          REAL      ARRAY    C            REFS       3       14       44
     0   C           REAL      ARRAY    C            REFS       2        5        6        7        8        9       10
                                                       11      12       13       14
     0   EI          REAL                F.P.        REFS      21       25       33       42   DEFINED      1
     0   EO          REAL                F.P.        REFS      22       23       24       27       35       44
                                                   DEFINED      1       21       23
     0   I           INTEGER             F.P.        REFS      21       25       27       33       35       41       42
                                                       44   DEFINED      1
     0   J           INTEGER             F.P.        REFS      22       23       24       25     2*26       28     2*29
                                                     2*30    3*31     2*32       33     2*34       36     2*37     2*38
                                                     3*39    2*40       42     2*43       45     2*46     2*47
                                                   DEFINED      1
   172   TEMP        REAL                            REFS      28       29       36       37       45       46
                                                   DEFINED     27       35       44
  3411   X1          REAL      ARRAY    C            REFS       4        5       39       43       46       47
                                                   DEFINED     42       46
  3420   X2          REAL      ARRAY    C            REFS       4        5       31       34       37       38       39
                                                       40   DEFINED     33       37       39
  3427   X3          REAL      ARRAY    C            REFS       4        7       23       26       29       30       31
                                                       32   DEFINED     23       29       31

EXTERNALS            TYPE   ARGS        REFERENCES
        QUAN                  3            22       24       26       28       30       32       34       36       38
                                           40       43       45       47

COMMON BLOCKS    LENGTH      MEMBERS - BIAS NAME(LENGTH)
        C         3830                 0 C      (3830)

EQUIV CLASSES    LENGTH      MEMBERS - BIAS NAME(LENGTH)
C       C         3830           3337 X1      (7)           3344 X2       (7)           3351 X3       (7)
                                 3358 A0      (4)           3362 A1       (4)           3366 A2       (4)
                                 3370 A3      (4)           3374 B1       (4)           3378 B2       (4)
                                 3382 B3      (4)

STATISTICS
  PROGRAM LENGTH                  173B      123
  CM LABELED COMMON LENGTH      7366B      3830
```

```
SUBROUTINE QUAN       74/74    OPT=1                          FTN 4.2+74355        07/07/75  11.06.56.       PAGE      1

                SUBROUTINE QUAN(XIN,I,J)                                                  C3        155
                COMMON /C/ C(3830)                                                        LABCO4     27
                DIMENSION REF(4,7),BIT(4,7)                                               C3        157.
                EQUIVALENCE (C(3387),REF(1,1))                                            C3        158
                EQUIVALENCE (C(3415)),BIT(1,1))                                           C3        159
          C     I IS STORAGE REGISTER 1 = EI, 2 = X1, 3 = X2, 4= X3, 5 = EJ               C3        160
          C     J IS FILTER 1= GUID PITCH CHANNEL, 2 = GUID YAW CHANNEL,                  C3        161
          C                 3 = INTRPITCH CHANNEL, 4 = INTR YAW CHANNEL,                  C3        162
          C                 5 = PITHPITCH CHANNEL, 6 = YAW  YAW CHANNEL,                  C3        163
          C                 7 = ROLL ROLL CHANNEL,                                        C3        164
                IF(XIN.EQ.0.)RETURN                                                       C3        165
                SIG =1.                                                                   C3        166
                IF(XIN.LT.0.)SIG =-1.                                                     C3        167
                XIN=ABS(XIN)                                                              C3        168
                IF(XIN.LT.REF(I,J))GO TO 10                                               C3        169
                WRITE(6,14)C(2000),XIN,I,J                                                C3        170
          14     FORMAT(* QUAN*,2E20.10,2I5)                                              C3        171
          10    XIN=XIN-AMOD(XIN,BIT(I,J))                                                C3        172
          100   XIN=SIG *XIN                                                              C3        173
                 RETURN                                                                   C3        174
                END                                                                       C3        175
```

```
      SUBROUTINE QUAN        74/74    OPT=1                         FTN 4.2+74355      07/07/75  11.06.56.        PAGE     2

            SYMBOLIC REFERENCE MAP (R=3)

  ENTRY POINTS       DEF LINE       REFERENCES
      3  QUAN              1            11          20

  VARIABLES       SN  TYPE              RELOCATION
   3526  SIT          REAL          ARRAY    C             REFS          3           5           18
      0  C            REAL          ARRAY    C             REFS          2           4            5          16
      0  I            INTEGER                  F.P.        REFS         15          16           18     DEFINED          1
      0  J            INTEGER                  F.P.        REFS         15          15           18     DEFINED          1
   3472  REF          REAL          ARRAY    C             REFS          3           4           15
     46  SIS          REAL                                 REFS         19     DEFINED           12          13
      0  XIN          REAL                     F.P.        REFS         11          13           14          15          16       2*18        19
                                                        DEFINED          1          14           18          19

  FILE NAMES          MODE
        TAPE6         FMT                      WRITES         16

  INLINE FUNCTIONS    TYPE     ARGS         DEF LINE    REFERENCES
        ABS           REAL       1  INTRIN                 14
        AMOD          REAL       2  INTRIN                 18

  STATEMENT LABELS                   DEF LINE    REFERENCES
     21  10                               18          15
     40  14            FMT                17          16
      0  100              INACTIVE        19

  COMMON BLOCKS     LENGTH       MEMBERS - BIAS NAME(LENGTH)
        C             3830                 0 C          (3830)

  EQUIV CLASSES     LENGTH       MEMBERS - BIAS NAME(LENGTH)
        C             3830              3386 REF     (28)                3414 BIT      (28)

  STATISTICS
    PROGRAM LENGTH                   47B        39
    CM LABELED COMMON LENGTH       7366B      3830
```

```
SUBROUTINE ATO        74/74    OPT=1                                    FTN 4.2+74355      07/07/76  11.06.58.        PAGE    1

                 SUBROUTINE   ATO(XIN,J)                                        C3        176
                 COMMON /C/ C(3830)                                             LABC04     28
                 DIMENSION REF(5),BIT(5)                                        C3        178
                 EQUIVALENCE (C(3443),REF)                                      C3        179
                 EQUIVALENCE (C(3448),BIT)                                      C3        180
           C     REF(1) IS WLAMQ                                                C3        181
           C     REF(2) IS WLAMR                                                C3        182
           C     REF(3) IS BXX                                                  C3        183
           C     REF(4) IS BTMS                                                 C3        184
           C     REF(5) IS BPSIS                                                C3        185
                 SIG =1.                                                        C3        186
                 IF(XIN.LT.0.)SIG =-1.                                          C3        187
                 XIN=ABS(XIN)                                                   C3        188
                 IF(XIN.LT.REF(  J))GO TO 10                                    C3        189
                 WRITE(6,14)C(2000),XIN,J                                       C3        190
           14    FORMAT(* ATOD *, 2E20.10,I5)                                   C3        191
           10    XIN=XIN-AMOD(XIN,BIT(J))                                       C3        192
           100   XIN=SIG *XIN                                                   C3        193
                 RETURN                                                         C3        194
                 END                                                            C3        195
```

```
SUBROUTINE ATD        74/74   OPT=1                        FTN 4.2+74355      07/07/75  11.06.58.       PAGE    2

        SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS       DEF LINE     REFERENCES
    3  ATD             1           19

 VARIABLES       SN  TYPE            RELOCATION
  3567  BIT          REAL       ARRAY    C              REFS      3        5        17
     0  C            REAL       ARRAY    C              REFS      2        4         5        15
     0  J            INTEGER                 F.P.       REFS     14       13        17   DEFINED      1
  3562  REF          REAL       ARRAY    C              REFS      3        4        14
    41  SIG          REAL                               REFS     10   DEFINED       11        12
     0  XIN          REAL                    F.P.       REFS     12       13        14        15     2*17      18
                                                     DEFINED      1       13        17        18

 FILE NAMES        MODE
      TAPE6        FMT                    WRITES        15

 INLINE FUNCTIONS    TYPE    ARGS        DEF LINE   REFERENCES
      ABS            REAL      1  INTRIN                 13
      AMOD           REAL      2  INTRIN                 17

 STATEMENT LABELS                    DEF LINE    REFERENCES
   17  10                               17          14
   33  15          FMT                  16          15
    0  100               INACTIVE       18

 COMMON BLOCKS    LENGTH      MEMBERS - BIAS NAME(LENGTH)
      C            3830                0 C      (3830)

 EQUIV CLASSES    LENGTH      MEMBERS - BIAS NAME(LENGTH)
 C     C           3830            3442 REF     (5)                  3447 BIT     (5)

 STATISTICS
   PROGRAM LENGTH                 42B       34
   CM LABELED COMMON LENGTH     7366B     3830
```

```
          SUBROUTINE   DTA(XIN,J)                              C3        196
          COMMON /C/ C(3830)                                   LABC04     29
          DIMENSION REF(4),BIT(4)                              C3        198
          EQUIVALENCE (C(3453),REF)                            C3        199
          EQUIVALENCE (C(3457),BIT)                            C3        200
C         REF(1 THRU 4) IS BDELTC(1 THRU 4)                    C3        201
          SIG =1.                                              C3        202
          IF(XIN.LT.0.)SIG =-1.                                C3        203
          XIN=ABS(XIN)                                         C3        204
          IF(XIN.LT.REF(  J))GO TO 10                          C3        205
          WRITE(6,14)C(2000),XIN,J                             C3        206
     14   FORMAT(* DTOA *,2E20.10,I5)                          C3        207
          XIN =REF(J)                                          C3        208
          GO TO 100                                            C3        209
     10   XIN=XIN-AMOD(XIN,BIT(J))                             C3        210
    100   XIN=SIG *XIN                                         C3        211
           RETURN                                              C3        212
          END                                                  C3        213
```

```
      SUBROUTINE DTA          74/74   OPT=1                            FTN 4.2+74355       07/07/75  11.06.58.        PAGE    2

      SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS      DEF LINE      REFERENCES
    3  DTA             1            17

 VARIABLES       SN  TYPE            RELOCATION
  3600  BIT          REAL       ARRAY    C            REFS       3        5        15
     0  C            REAL       ARRAY    C            REFS       2        4         5       11
     0  J            INTEGER             F.P.         REFS      10       11        13       15       DEFINED      1
  3574  REF          REAL       ARRAY    C            REFS       3        4        10       13
    46  SIG          REAL                             REFS      16     DEFINED      7        8
     0  XIN          REAL                F.P.         REFS       8        9        10       11       2*15        16
                                                    DEFINED      1        9        13       15        16

 FILE NAMES        MODE
       TAPE6       FMT                  WRITES        11

 INLINE FUNCTIONS    TYPE    ARGS          DEF LINE   REFERENCES
       ABS           REAL      1  INTRIN                  9
       AMOD          REAL      2  INTRIN                 15

 STATEMENT LABELS             DEF LINE     REFERENCES
    22  10                       15           10
    40  14          FMT          12           11
    27  101                      16           14

 COMMON BLOCKS    LENGTH        MEMBERS - BIAS NAME(LENGTH)
       C            3830                 0 C      (3830)

 EQUIV CLASSES    LENGTH       MEMBERS - BIAS NAME(LENGTH)
       C            3830           3492 REF     (4)              3496 BIT     (4)

 STATISTICS
   PROGRAM LENGTH              47B         39
   CM LABELED COMMON LENGTH    7366B      3830
```

```
      SUBROUTINE C4I
      COMMON /C/ C(3830)
      DIMENSION IPL(100), ISNOX(40)
C
C**INPUT DATA
      EQUIVALENCE (C(1143),WDELTL)
      EQUIVALENCE (C(1144),GDELT)
C

      EQUIVALENCE (C(3634), ISNOX), (C(3512), I3512)
      DIMENSION BDELT(4)
      EQUIVALENCE (C(1103),BDELT1)
      EQUIVALENCE (C(1107),BDELT2)
      EQUIVALENCE (C(1111),BDELT3)
      EQUIVALENCE (C(1115),BDELT4)
      EQUIVALENCE (C(1101),FELECB)
      EQUIVALENCE (C(1102),FELECQ3)
      EQUIVALENCE (C(1105),FELECR3)
      EQUIVALENCE (C(1106),FMECHB)
      EQUIVALENCE (C(1109),FMECHQ3)
      EQUIVALENCE (C(1110),FMECHR3)
      EQUIVALENCE (C(1254), DELTB)
      EQUIVALENCE (C(1255),DELTQB)
      EQUIVALENCE (C(1256),DELTRB)
      EQUIVALENCE (C(1140),OPTACT)
      EQUIVALENCE (C(1231),BOP   )
      EQUIVALENCE (C(1232),BDQ   )
      EQUIVALENCE (C(1233),BDR   )
      EQUIVALENCE (C(2561),N     )
      EQUIVALENCE (C(2562),IPL   )
C
      DATA WDELTL, GDELT/ 200.000,15.000/
C
      IPL(N) = 1100
      IPL(N+1) = 1104
      IPL(N+2) = 1108
      IPL(N+3) = 1112
      N = N+4
C
C MONTE CARLO FIN MISALIGNMENT ERRORS
C
      FELECB  = 0.
      FELECQB = 0.
      FELECRB = 0.
      FMECHB  = 0.
      FMECHQB = 0.
      FMECHRB = 0.
      DO 10 I = 1, I3512
      IDO = I
      IF(ISNOX(I).EQ.1106) CALL MCARLO (DUM, 1, IDO)
      IF(ISNOX(I).EQ.1109) CALL MCARLO (DUM, 1, IDO)
      IF(ISNOX(I).EQ.1110) CALL MCARLO (DUM, 1, IDO)
C
C  MONTE CARLO FIN OFFSET
      IF(ISNOX(I).EQ.1101) CALL MCARLO (DUM, 1, IDO)
      IF(ISNOX(I).EQ.1102) CALL MCARLO (DUM, 1, IDO)
      IF(ISNOX(I).EQ.1105) CALL MCARLO (DUM, 1, IDO)
```

```
          10  CONTINUE                                                         C4      59
              ENTRY A1I                                                        C4      60
              DELTB  = FELECB  + FMECHB                                        C4      61
              DELTQB = FELECQB + FMECHQB                                       C4      62
              DELTRB = FELECRB + FMECHQB                                       C4      63
              BDELT1 = -BDP + BDQ - BDR                                        C4      64
              BDELT2 = -BDP + BDQ + BDR                                        C4      65
              BDELT3 =  BDP + BDQ - BDR                                        C4      66
              BDELT4 =  BDP + BDQ + BDR                                        C4      67
              BDELT1 = BDELT1 - DELTB + DELTQB - DELTRB                        C4      68
              BDELT2 = BDELT2 - DELTB + DELTQB + DELTRB                        C4      69
              BDELT3 = BDELT3 + DELTB + DELTQB - DELTRB                        C4      70
              BDELT4 = BDELT4 + DELTB + DELTQB + DELTRB                        C4      71
              RETURN                                                           C4      72
              END                                                              C4      73
        C**  HELFIRE SIMPLIFIED ACTUATOR MODEL                                 C4      74
        C****** NON - LINEAR MODEL ******                                      C4      75
        C                                                                      C4      76
```

```
         SUBROUTINE C4I         74/74    OPT=1                              FTN 4.2+74355       07/07/75  11.06.59.       PAGE      3

         SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS         DEF LINE       REFERENCES
    53  A1I                59           71
     1  C4I                 1

 VARIABLES        SN   TYPE               RELOCATION
    111  BDELT       REAL          *UNDEF                   REFS        11
   2116  BDELT1      REAL                    C              REFS        12        67     DEFINED        63        67
   2122  BDELT2      REAL                    C              REFS        13        68     DEFINED        64        68
   2126  BDELT3      REAL                    C              REFS        14        69     DEFINED        65        69
   2132  BDELT4      REAL                    C              REFS        15        70     DEFINED        66        70
   2316  BDP         REAL                    C              REFS        26        63        64          65        66
   2317  BDQ         REAL                    C              REFS        27        63        64          65        66
   2320  BDR         REAL                    C              REFS        28        63        64          65        66
      0  C           REAL          ARRAY     C              REFS         2         5         7        2*10        12        13        14
                                                              15        16        17        18          19        20        21        22
                                                              23        24        25        26          27        28        29        30
   2345  DELT3       REAL                    C              REFS        22        67        68          69        70
                                                         DEFINED        60
   2346  DELTQB      REAL                    C              REFS        23        67        68          69        70
                                                         DEFINED        61
   2347  DELTRB      REAL                    C              REFS        24        67        68          69        70
                                                         DEFINED        62
    110  DUM         REAL                                   REFS        50        51        52          55        56        57
   2114  FELECB      REAL                    C              REFS        16        60     DEFINED        42
   2115  FELECQB     REAL                    C              REFS        17        61     DEFINED        43
   2120  FELECRB     REAL                    C              REFS        18        62     DEFINED        44
   2121  FMECHB      REAL                    C              REFS        19        60     DEFINED        45
   2124  FMECHQB     REAL                    C              REFS        20        61        62     DEFINED        46
   2125  FMECHRB     REAL                    C              REFS        21     DEFINED      47
   2107  GDELT       REAL                    C              REFS         7     DEFINED      32
    106  I           INTEGER                                REFS        49        50        51          52        55        56        57
                                                         DEFINED        48
    107  IDD         INTEGER                                REFS        50        51        52          55        56        57
                                                         DEFINED        49
   7001  IPL         INTEGER       ARRAY     C              REFS         3        30     DEFINED        34        35        36        37
   7061  ISNDX       INTEGER       ARRAY     C              REFS         3        10        50          51        52        55        56
                                                              57
   3057  IS512       INTEGER                 C              REFS        10        48
   3000  N           INTEGER                 C              REFS        29        34        35          36        37        38
                                                         DEFINED        38
   2103  OPTAST      REAL                    C              REFS        25
   2106  WDELTL      REAL                    C              REFS         6     DEFINED      32

 EXTERNALS            TYPE   ARGS         REFERENCES
        MCARLO                 3              50        51        52        55        56        57

 STATEMENT LABELS              DEF LINE     REFERENCES
     0  10                        58          48

 LOOPS  LABEL     INDEX      FROM-TO      LENGTH    PROPERTIES
    16  10        * I        48 58          349                      EXT REFS

 COMMON BLOCKS    LENGTH       MEMBERS - BIAS NAME(LENGTH)
        C          3830                0 C      (3830)
```

```
EQUIV CLASSES   LENGTH     MEMBERS - BIAS NAME(LENGTH)
C      C          3830          1100 FELECB  (1)           1101 FELECQB(1)            1132 BDELT1  (1)
                                1104 FELECRB (1)           1105 FMECHB  (1)           1136 BDELT2  (1)
                                1108 FMECHQB (1)           1109 FMECHRB(1)            1110 BDELT3  (1)
                                1114 BDELT4  (1)           1139 OPTACT  (1)           1142 WDELTL  (1)
                                1143 GDELT   (1)           1230 BDP     (1)           1231 BDQ     (1)
                                1232 BDR     (1)           1253 DELTB   (1)           1254 DELTQB  (1)
                                1255 DELTRB  (1)           2560 N       (1)           2551 IPL   (100)
                                3511 I3512   (1)           3633 ISNDX  (40)

STATISTICS
  PROGRAM LENGTH                1158       77
  CM LABELED COMMON LENGTH     73668     3830
```

AD-A032 048 ARMY MISSILE RESEARCH DEVELOPMENT AND ENGINEERING LAB--ETC F/G 16/4
THAD T-7 MISSILE MONTE-CARLO TERMINAL HOMING SIMULATION UTILIZI--ETC(U)
JUL 76 C L LEWIS, W R HOOKER, A W LEE
UNCLASSIFIED RG-7T-2 NL

6 OF 7
ADA032048

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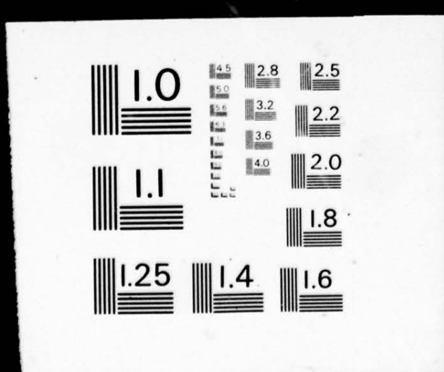

```
          SUBROUTINE C4                                          C4     77
C                                                                C4     78
          COMMON /C/ C(3838)                                     C4     79
          DIMENSION BDELTD(4),BDELT(4),BDELTC(4)                 C4     80
C                                                                C4     81
C**INPUT DATA                                                    C4     82
          EQUIVALENCE (C(1143),WDELTL)                           C4     83
          EQUIVALENCE (C(1144),GDELT)                            C4     84
C                                                                C4     85
C**INPUTS FROM OTHER MODULES                                     C4     86
          EQUIVALENCE (C( 556),BDELTC)                           C4     87
          EQUIVALENCE (C(1254), DELTB)                           C4     88
          EQUIVALENCE (C(1255),DELTQB)                           C4     89
          EQUIVALENCE (C(1256),DELTRB)                           C4     90
C**STATE VARIABLE OUTPUTS                                        C4     91
          BDELTC(1) = BDELTC(1) - DELTB + DELTQB - DELTRB        C4     92
          BDELTC(2) = BDELTC(2) - DELTB + DELTQB + DELTRB        C4     93
          BDELTC(3) = BDELTC(3) + DELTB + DELTQB - DELTRB        C4     94
          BDELTC(4) = BDELTC(4) + DELTB + DELTQB + DELTRB        C4     95
          BDELT(1)=C(1103)                                       C4     96
          BDELT(2)=C(1107)                                       C4     97
          BDELT(3)=C(1111)                                       C4     98
          BDELT(4)=C(1115)                                       C4     99
C                                                                C4    100
C**ACTUATOR DYNAMICS                                             C4    101
          DO 30  I=1,4                                           C4    102
          IF(ABS(BDELT(I)) .GT. 20.)BDELT(I)=SIGN(20.,BDELT(I))  C4    103
    31    BDELTD(I)=GDELT*(BDELTC(I)-BDELT(I))                   C4    104
          IF(ABS(BDELTD(I)).GT.WDELTL)BDELTD(I)=SIGN(WDELTL,BDELTD(I))  C4    105
    32    CONTINUE                                               C4    106
    30    CONTINUE                                               C4    107
C                                                                C4    108
          C(1103) = BDELT(1)                                     C4    109
          C(1107) = BDELT(2)                                     C4    110
          C(1111) = BDELT(3)                                     C4    111
          C(1115) = BDELT(4)                                     C4    112
C                                                                C4    113
C**OUTPUT DERIVATIVES OF STATE VARIABLES TO INTEGRATION          C4    114
          C(1100) = BDELTD(1)                                    C4    115
          C(1104) = BDELTD(2)                                    C4    116
          C(1108) = BDELTD(3)                                    C4    117
          C(1112) = BDELTD(4)                                    C4    118
C                                                                C4    119
          RETURN                                                 C4    120
          END                                                    C4    121
```

```
        SUBROUTINE C4         74/74    OPT=1                                   FTN 4.2+74355      07/07/75  11.07.01.       PAGE     2

        SYMBOLIC REFERENCE MAP (R=3)

  ENTRY POINTS      DEF LINE      REFERENCES
     1  C4                 1          44

  VARIABLES       SN  TYPE              RELOCATION
     63  BDELT        REAL          ARRAY                 REFS          4       2*27        20        33        34        35        36
                                                       DEFINED         20         21        22        23        27
   1527  BDELTC       REAL          ARRAY     C           REFS          4         11        16        17        18        19        28
                                                       DEFINED         16         17        18        19
     57  BDELTD       REAL          ARRAY                 REFS          4       2*29        39        40        41        42
                                                       DEFINED         28         29
      0  C            REAL          ARRAY     C           REFS          3          7         8        11        12        13        14
                                                            20         21         22        23   DEFINED        33        34        35
                                                            36         39         40        41        42
   2345  DELTB        REAL                    C           REFS         12         15        17        18        19
   2346  DELTQB       REAL                    C           REFS         13         15        17        18        19
   2347  DELTRB       REAL                    C           REFS         14         15        17        18        19
   2167  GDELT        REAL                    C           REFS          8         23
     56  I            INTEGER                             REFS       3*27       3*28      3*29   DEFINED        26
   2166  WDELTL       REAL                    C           REFS          7       2*29

  INLINE FUNCTIONS      TYPE     ARGS          DEF LINE   REFERENCES
        ABS             REAL       1   INTRIN                  27        29
        SIGN            REAL       2   INTRIN                  27        29

  STATEMENT LABELS                      DEF LINE     REFERENCES
     0  30                                  31          26
     0  31             INACTIVE             28
     0  32             INACTIVE             30

  LOOPS  LABEL      INDEX         FROM-TO       LENGTH      PROPERTIES
    27   30         I              26 31          13B          OPT

  COMMON BLOCKS     LENGTH       MEMBERS - BIAS NAME(LENGTH)
        C            3830                  0 C        (3830)

  EQUIV CLASSES     LENGTH       MEMBERS - BIAS NAME(LENGTH)
 C      C            3830              355 BDELTC  (4)                 1142 WDELTL  (1)                    1143 GDELT   (1)
                                      1253 DELTB   (1)                 1254 DELTQB  (1)                    1255 DELTRB  (1)

  STATISTICS
    PROGRAM LENGTH                     67B        55
    CM LABELED COMMON LENGTH         7366B      3830
```

```
      SUBROUTINE C5I
      COMMON /C/ C(3830)
      DIMENSION IPL(100),BDELT(4)
      DIMENSION G1(4),G2(4),W1(4),ZN(4),WN(4)
C
C**INPUT DATA
      EQUIVALENCE (C(1120),G1)
      EQUIVALENCE (C(1124),ZN)
      EQUIVALENCE (C(1128),W1)
      EQUIVALENCE (C(1132),G2)
      EQUIVALENCE (C(1136),WN)
      EQUIVALENCE (C(1147),HDEL)
C
      EQUIVALENCE (C(1103),BDELT1)
      EQUIVALENCE (C(1107),BDELT2)
      EQUIVALENCE (C(1111),BDELT3)
      EQUIVALENCE (C(1115),BDELT4)
      EQUIVALENCE (C(1231),BOP)
      EQUIVALENCE (C(1232),BOQ)
      EQUIVALENCE (C(1233),BOR)
      EQUIVALENCE (C(2561),N)
      EQUIVALENCE (C(2562),IPL)
      DATA G1/44.,44.,42.,40./
      DATA ZN/.9,1.,.55,.8/
      DATA W1/7.79,9.18,6.89,8.85/
      DATA G2/1.29,1.51,.9,1.18/
      DATA WN/230.,230.,230.,230./
      DATA HDEL /240.0/

      IPL(N  )=1100
      IPL(N+1)=1104
      IPL(N+2)=1108
      IPL(N+3)=1112
      IPL(N+4)=1160
      IPL(N+5)=1164
      IPL(N+6)=1168
      IPL(N+7)=1172
      IPL(N+8)=1176
      IPL(N+9)=1180
      IPL(N+10)=1184
      IPL(N+11)=1188
      N=N+12
      C(1103)=0.
      C(1107)=0.
      C(1111)=0.
      C(1115)=0.
      C(1163)=0.
      C(1167)=0.
      C(1171)=0.
      C(1175)=0.
      C(1179)=0.
      C(1183)=0.
      C(1187)=0.
      C(1191)=0.
      C(1141)=0.   $  C(1142)=0.   $  C(1143)=0.
      RETURN
      END
```

```
        SUBROUTINE CSI        74/74    OPT=1                      FTN 4.2+74.353      07/07/75  11.07.02.       PAGE    2

        SYMBOLIC REFERENCE MAP (R=3)

  ENTRY POINTS       DEF LINE      REFERENCES
     1 CSI               1            56

  VARIABLES       SN  TYPE              RELOCATION
    37  BDELT         REAL       *UNDEF                  REFS      3
  2116  BDELT1        REAL                 C             REFS     14
  2122  BDELT2        REAL                 C             REFS     15
  2126  BDELT3        REAL                 C             REFS     16
  2132  BDELT4        REAL                 C             REFS     17
  2316  BDP           REAL                 C             REFS     18
  2317  BDQ           REAL                 C             REFS     19
  2320  BDR           REAL                 C             REFS     20
     0  C             REAL       ARRAY     C             REFS      2        7        8        9       10       11       12
                                                           14     15       15       17       18       19       20       21
                                                           22  DEFINED     43       44       45       46       47       48
                                                           49     50       51       52       53       54      3*55
  2137  G1            REAL       ARRAY     C             REFS      4        7   DEFINED     23
  2153  G2            REAL       ARRAY     C             REFS      4       10   DEFINED     26
  2172  HDEL          REAL                 C             REFS     12  DEFINED       26
  3001  IPL           INTEGER    ARRAY     C             REFS      3       22   DEFINED     30       31       32       33
                                                           34     35       36       37       38       39       40       41
  3000  N             INTEGER              C             REFS     21       30       31       32       33       34       35
                                                           36     37       38       39       40       41       42
                                                      DEFINED     42
  2157  WN            REAL       ARRAY     C             REFS      4       11   DEFINED     27
  2147  W1            REAL       ARRAY     C             REFS      4        9   DEFINED     25
  2143  ZN            REAL       ARRAY     C             REFS      4        9   DEFINED     24

  COMMON BLOCKS    LENGTH     MEMBERS - BIAS NAME(LENGTH)
        C           3830                0 C        (3830)

  EQUIV CLASSES    LENGTH     MEMBERS - BIAS NAME(LENGTH)
  C     C           3830          1102 BDELT1  (1)           1106 BDELT2  (1)           1110 BDELT3  (1)
                                  1114 BDELT4  (1)           1119 G1      (4)           1123 ZN      (4)
                                  1127 W1      (4)           1131 G2      (4)           1135 WN      (4)
                                  1146 HDEL    (1)           1230 BDP     (1)           1231 BDQ     (1)
                                  1232 BDR     (1)           2560 N       (1)           2551 IPL     (100)

  STATISTICS
    PROGRAM LENGTH                 43B       35
    CM LABELED COMMON LENGTH     7366B     3830
```

```
      SUBROUTINE C5
      COMMON /C/ C(3830)
      DIMENSION BDELTD(4),BDELT(4),BDELTC(4)
      DIMENSION               WDS2D(4),WDS2(4),WDS1D(4),WDS1(4)
      DIMENSION        NC2(2),C82(6),CHDF(6)
      DIMENSION G1(4),G2(4),W1(4),ZN(4),WN(4)
C
C** INPUT DATA
      EQUIVALENCE (C(1140),OPTACT)
      EQUIVALENCE (C(1141),BDP)
      EQUIVALENCE (C(1142),BDQ)
      EQUIVALENCE (C(1143),BDR)
      EQUIVALENCE (C(1147),HDEL)
      EQUIVALENCE (C(1120),G1)
      EQUIVALENCE (C(1124),ZN)
      EQUIVALENCE (C(1128),W1)
      EQUIVALENCE (C(1132),G2)
      EQUIVALENCE (C(1136),WN)
C
C** INPUTS FROM OTHER MODULES
      EQUIVALENCE (C( 204),VMACH)
      EQUIVALENCE (C( 556),BDELTC)
C
C
      DATA NC2/6,0/
      DATA C82/.00,.50,.85,1.05,1.40,3.60/
      DATA CHDF/0.0,.8F,2.50,6.20,10.6,12.5/
C** FLAP BIAS
      BDELTC(1)=BDELTC(1)-BDP+BDQ-BDR
      BDELTC(2)=BDELTC(2)-BDP+BDQ+BDR
      BDELTC(3)=BDELTC(3)+BDP+BDQ-BDR
      BDELTC(4)=BDELTC(4)+BDP+BDQ+BDR
C
C** STATE VARIABLE OUTPUTS
      BDELT(1)=C(1103)
      BDELT(2)=C(1107)
      BDELT(3)=C(1111)
      BDELT(4)=C(1115)
      WDS2 (1)=C(1163)
      WDS2 (2)=C(1167)
      WDS2 (3)=C(1171)
      WDS2 (4)=C(1175)
      WDS1 (1)=C(1179)
      WDS1 (2)=C(1183)
      WDS1 (3)=C(1187)
      WDS1 (4)=C(1191)
C
C** ACTUATOR DYNAMICS
      VM=AMIN1(VMACH,1.4)
      CALL TABLE(VM,C82,CHDF,NC2,KK,HHNGE,FKHD)
      DO 30 I=1,4
      H1=HDEL
      H2=H1*2.
      IF(ABS(OPTACT).LE.1.) GO TO 3
      IF(I.GE.3) GO TO 5
      GO TO 4
    3 IF(I.GE.2.AND.I.LE.3) GO TO 5
```

```
    4 M2=M1                                                          C5      116
      M1=M1*2.                                                       C5      117
    5 CONTINUE                                                       C5      118
    6 A1=G1(I)*(WDS1(I)-BDELT(I))                                    C5      119
      IF(A1.LT.-M2) A1=-M2                                           C5      120
      IF(A1.GT.M1) A1=M1                                             C5      121
      WDS1D(I)=WDS2(I)                                               C5      122
      WDS2D(I)=WN(I)*(WN(I)*(BDELTC(I)-WDS1(I))-2.*ZN(I)*WDS1D(I))   C5      123
      BDELTD(I)=(A1-G2(I)*FMMD*BDELT(I))/(1.+G2(I)*FMMD/W1(I))       C5      124
C                                                                    C5      125
C** SURFACE POSITION LIMITER                                         C5      126
      IF(ABS(BDELT(I)).GT.19..AND.BDELTD(I)*BDELT(I).GT.0.) BDELTD(I)=0. C5  127
   30 CONTINUE                                                       C5      128
      C(1103)=BDELT(1)                                               C5      129
      C(1107)=BDELT(2)                                               C5      130
      C(1111)=BDELT(3)                                               C5      131
      C(1115)=BDELT(4)                                               C5      132
C                                                                    C5      133
C** OUTPUT STATE VARIABLE DERIVITIVES                                C5      134
      C(1100)=BDELTD(1)                                              C5      135
      C(1104)=BDELTD(2)                                              C5      136
      C(1108)=BDELTD(3)                                              C5      137
      C(1112)=BDELTD(4)                                              C5      138
      C(1160)=WDS2D(1)                                               C5      139
      C(1164)=WDS2D(2)                                               C5      140
      C(1168)=WDS2D(3)                                               C5      141
      C(1172)=WDS2D(4)                                               C5      142
      C(1176)=WDS1D(1)                                               C5      143
      C(1180)=WDS1D(2)                                               C5      144
      C(1184)=WDS1D(3)                                               C5      145
      C(1188)=WDS1D(4)                                               C5      146
      RETURN                                                         C5      147
      END                                                            C5      148
```

```
     SUBROUTINE C5          74/74    OPT=1                              FTN 4.2+74.355       07/07/75  11.07.05.        PAGE    3

     SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE      REFERENCES
   1  C5                 1          89

VARIABLES        SN  TYPE               RELOCATION
   167  AI             REAL                               REFS         62        63        66   DEFINED        61        62        63
   174  BDELT          REAL          ARRAY                REFS          3        61        66      2*63        71        72        73
                                                            74    DEFINED        35        36        37        38
  1527  BDELTC         REAL          ARRAY     C          REFS          3        22        29        30        31        32        65
                                                       DEFINED         29        30        31        32
   170  BDELTD         REAL          ARRAY                REFS          3        63        77        78        79        80
                                                       DEFINED         66        63
  2164  BDP            REAL                    C          REFS         10        23        30        31        32
  2165  BDQ            REAL                    C          REFS         11        23        30        31        32
  2166  BDR            REAL                    C          REFS         12        23        30        31        32
     0  C              REAL          ARRAY     C          REFS          2         9        10        11        12        13        14
                                                            15         16        17        18        21        22        35        36
                                                            37         38        39        40        41        42        43        44
                                                            45         46   DEFINED        71        72        73        74        77
                                                            78         79        80        81        82        83        84        85
                                                            86         87        88
   222  CB2            REAL          ARRAY                REFS          5        50   DEFINED        26
   230  CHDF           REAL          ARRAY                REFS          5        50   DEFINED        27
   163  FMID           REAL                               REFS         50      2*66
  2137  G1             REAL          ARRAY     C          REFS          5        14        61
  2153  G2             REAL          ARRAY     C          REFS          6        17      2*66
  2172  HDEL           REAL                    C          REFS         13        52
   165  H1             REAL                               REFS         53        59        59      2*63   DEFINED        52        59
   166  H2             REAL                               REFS       2*62   DEFINED        53        58
   164  I              INTEGER                            REFS         55      2*57      3*61      2*64      7*65      5*66      4*69
                                                       DEFINED         51
   220  NC2            INTEGER       ARRAY                REFS          5        50   DEFINED        25
  2163  OPTACT         REAL                    C          REFS          9        54
   161  VM             REAL                               REFS         50   DEFINED        49
   313  VMACH          REAL                    C          REFS         21        43
   214  WDS1           REAL          ARRAY                REFS          4        61        65   DEFINED        43        44        45
                                                            46
   210  WDS1D          REAL          ARRAY                REFS          4        65        85        86        87        88
                                                       DEFINED         64
   204  WDS2           REAL          ARRAY                REFS          4        64   DEFINED        39        40        41        42
   200  WDS2D          REAL          ARRAY                REFS          4        81        82        83        84
                                                       DEFINED         65
  2157  WN             REAL          ARRAY     C          REFS          6        13      2*65
  2147  W1             REAL          ARRAY     C          REFS          6        15        66
   162  XK           * REAL                               REFS         50
  2143  ZN             REAL          ARRAY     C          REFS          6        15        65

EXTERNALS              TYPE    ARGS         REFERENCES
     TABLE                        7             50

INLINE FUNCTIONS     TYPE    ARGS         DEF LINE   REFERENCES
       ABS           REAL       1  INTRIN                54        69
       AMIN1         REAL       0  INTRIN                49
```

```
      SUBROUTINE C5           74/74   OPT=1                               FTN 4.2+74355        07/07/76  11.07.05.        PAGE     4

 STATEMENT LABELS                   DEF LINE   REFERENCES
    56  3                              57         54
    62  4                              58         56
    64  5                              60         55          57
     0  6              INACTIVE        61
     0  30                             70         51

 LOOPS  LABEL    INDEX       FROM-TO     LENGTH      PROPERTIES
    47  30      * I           51 70       473          OPT

 COMMON BLOCKS    LENGTH       MEMBERS - BIAS NAME(LENGTH)
       C             3830                 0 C         (3830)

 EQUIV CLASSES    LENGTH       MEMBERS - BIAS NAME(LENGTH)
 C        C          3830               203 VMACH    (1)                       855 BDELTC  (4)                1119 G1      (4)
                                       1123 ZN       (4)                      1127 W1      (4)                1131 G2      (4)
                                       1135 WN       (4)                      1139 OPTACT  (1)                1140 BOP     (1)
                                       1141 BDQ      (1)                      1142 BDR     (1)                1146 HDEL    (1)

 STATISTICS
   PROGRAM LENGTH                   2408B      1608
   CM LABELED COMMON LENGTH        7366B      3830
```

```
      SUBROUTINE G4                                                     G4          2
C*************************************************************         G4          3
C** THIS IS A SUBROUTINE (NOT A MODULE) CALLED BY STAGE 3 **           G4          4
C** STOPS PROGRAM AND COMPUTES MISS DISTANCE                **          G4          5
C*************************************************************         G4          6
      COMMON /C/ C(3830)                                                LABC04     34
  100 FORMAT(1H0,17H MISS DISTANCE = ,1PE15.7/                          G4          8
     *      1H0,17H FLIGHT  TIME  = ,1PE15.7)                           G4          9
  200 FORMAT(1H0, 9X,8HRDELX = ,1PE15.7, 3X,8HRDELY = ,1PE15.7,         G4         10
     *            8X,8HRDELZ = ,1PE15.7)                                G4         11
  300 FORMAT(1H0,40X,8HRYFP  = ,1PE15.7, 8X,8HRZFP  = ,1PE15.7)         G4         12
      EQUIVALENCE (C( 357),BGAMH )                                      G4         13
     *,           (C( 358),BGAMV )                                      G4         14
     *,           (C( 371),RANGE )                                      G4         15
     *,           (C(1635),RDELX )                                      G4         16
     *,           (C(1636),RDELY )                                      G4         17
     *,           (C(1637),RDELZ )                                      G4         18
      EQUIVALENCE (C(2000),T     )                                      G4         19
      EQUIVALENCE (C(1564),YMC)                                         G4         20
      EQUIVALENCE (C(1565),YMC2)                                        G4         21
      EQUIVALENCE (C(1574),ZMC)                                         G4         22
      EQUIVALENCE (C(1575),ZMC2)                                        G4         23
     *,           (C(3020),LCONV )                                      G4         24
      EQUIVALENCE (C( 300),RMISS )                                      G4         25
     *,           (C( 301),L     )                                      G4         26
     *,           (C( 302),RYF   )                                      G4         27
     *,           (C( 303),RZF   )                                      G4         28
      EQUIVALENCE (C( 31), LCEP)                                        G4         29
      EQUIVALENCE (C(3721),   ITCT)                                     G4         30
      EQUIVALENCE (C(3000),VSD   )                                      G4         31
      EQUIVALENCE (C(3010),VMEAN )                                      G4         32
      EQUIVALENCE (C(3020),IMVNDX)                                      G4         33
      EQUIVALENCE (C(3030),IMVCT )                                      G4         34
      DIMENSION IMVNDX(10), VMEAN(10), VSD(10)                          G4         35
      DIMENSION VSUM(10), VS2(10)                                       G4         36
      LCEP = 0                                                          G4         37
      IF (RANGE .GT. 500.) GO TO 20                                     G4         38
      UC13 =-SIND(BGAMV)                                                G4         39
      UC33 = COSD(BGAMV)                                                G4         40
      UC21 =-SIND(BGAMH)                                                G4         41
      UC22 = COSD(BGAMH)                                                G4         42
      UC11 =  UC22*UC33                                                 G4         43
      UC12 = -UC21*UC33                                                 G4         44
      UC31 = -UC22*UC13                                                 G4         45
      UC32 =  UC21*UC13                                                 G4         46
      RXFP = UC11*RDELX + UC12*RDELY + UC13*RDELZ                       G4         47
      RYFP = UC21*RDELX + UC22*RDELY                                    G4         48
      RZFP = UC31*RDELX + UC32*RDELY + UC33*RDELZ                       G4         49
      IF (RXFP .GT. 0.) GO TO 10                                        G4         50
      IF(IMVCT .LE. 0) GO TO 50                                         G4         51
      DO 5 I=1,IMVCT                                                    G4         52
      IDO = IMVNDX(I)                                                   G4         53
      VALUE = C(IDO)                                                    G4         54
      VSUM(I) = VSUM(I) + VALUE                                         G4         55
      VS2(I) = VS2(I) + VALUE**2                                        G4         56
      TCASE = L                                                         G4         57
      TCASE1 = L - 1                                                    G4         58
```

```
      VMEAN(I) = VSUM(I)/TCASE
      IF(L .NE. 1) GO TO 2
      S2 = (VS2(I) - (VSUM(I)**2)/TCASE)/TCASE
      GO TO 3
    2 S2 = (VS2(I) - (VSUM(I)**2)/TCASE)/TCASE1
    3 VSD(I) = SQRT(S2)
    5 CONTINUE
   50 CONTINUE
      PCT = UXFP/(RXFP - UXFP)
      RDX = UDELX - PCT*(RDELX - UDELX)
      RDY = UDELY - PCT*(RDELY - UDELY)
      RDZ = UDELZ - PCT*(RDELZ - UDELZ)
      RYF = UYFP - PCT*(RYFP - UYFP)
      RZF = UZFP - PCT*(RZFP - UZFP)
      TZERO = UT - PCT*(T - UT)
      RMISS = SQRT(RYF**2 + RZF**2)
      PITCH=10H PITCH
      YAW=10H YAW
      WRITE(6,600)C(630),PITCH
      WRITE(6,600)C(631),YAW
  600 FORMAT(1H0,60X,*++++MAX BREAKLOCK VALUE =*F10.5,*  IN *A10)
      WRITE(6,400) L
  400 FORMAT(1H0,13HRUN NUMBER = ,I2)
      IF(ITCT.LE.0)GO TO 30
      CALL MCARLX(DUM,2,RNSTRT)
      WRITE(6,500) C(1567), C(1563), C(1577), C(1578)
      XMCSPOT = SQRT(YMC2*YMC2 + ZMC2*ZMC2)
      WRITE(6,2555)YMC,YMC2
      WRITE(6,2556)ZMC,ZMC2,XMCSPOT
   30 CONTINUE
  500 FORMAT(1H0,11X,13HMAX SPOT Y = ,F6.2,14H MIN SPOT Y = , F6.2/
     1          12X,13HMAX SPOT Z = ,F6.2,14H MIN SPOT Z = ,F6.2//
     2 )
 2555 FORMAT(1H0,11X,26HSAMPLE SPOT JITTER Y-MEAN=,F10.5,6X,12HMEAN SQUA
     1RE=,F10.5)
 2556 FORMAT(1H0,11X,26HSAMPLE SPOT JITTER Z-MEAN=,F10.5,6X,12HMEAN SQUA
     1RE=,F10.5,6X,18HSPOT RADIAL RMS = ,F10.5)
      WRITE(6,100) RMISS, TZERO
      WRITE(6,200) RDX, RDY, RDZ
      WRITE(6,300) RYF, RZF
      LCONV = 2
      LCOP = 1
      RETURN
   10 UT = T
      UDELX = RDELX
      UDELY = RDELY
      UDELZ = RDELZ
      UXFP = RXFP
      UYFP = RYFP
      UZFP = RZFP
      RETURN
   20 IF (RDELZ .LT. 0.) LCONV = 2
      RETURN
      END
```

CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
58	I	IMVCT	THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.
63	I	IMVCT	THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.

```
     SUBROUTINE G4          74/74    OPT=1                          FTN 4.2+74355      07/07/75  11.07.07.      PAGE     4

     SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE     REFERENCES
   1  G4               1        100        108        110

VARIABLES       SN  TYPE            RELOCATION
   544  BGAMM       REAL                C             REFS       12        40        41
   545  BGAMV       REAL                C             REFS       12        38        39
     0  C           REAL        ARRAY   C             REFS        6       5*12       18        19        20        21      2*22
                                                      4*24       28        29        30        31        32        33        53
                                                        76       77       4*83
   433  DUM       * REAL                              REFS       82
   407  I           INTEGER                           REFS       52       2*54      2*55      2*58      2*60      2*62       63
                                                   DEFINED       51
   410  IDD         INTEGER                           REFS       53     DEFINED      52
  5725  INVCT       INTEGER             C             REFS       33        50        51
  5713  INVNDX      INTEGER     ARRAY   C             REFS       32        34        52
  7210  ITOT        INTEGER             C             REFS       29        81
   454  L           INTEGER             C             REFS       24        56        57        59        79
    36  LCEP        INTEGER             C             REFS       28     DEFINED      36        99
  5743  LCONV       INTEGER             C             REFS       22     DEFINED      38       109
   415  PCT         REAL                              REFS       67        68        69        70        71        72
                                                   DEFINED       66
   431  PITCH       REAL                              REFS       76     DEFINED      74
   562  RANGE       REAL                C             REFS       12        37
  3142  RDELX       REAL                C             REFS       12        46        47        48        67       102
  3143  RDELY       REAL                C             REFS       12        45        47        48        68       103
  3144  RDELZ       REAL                C             REFS       12        46        48        69       104       109
   417  RDX         REAL                              REFS       96     DEFINED      67
   421  RDY         REAL                              REFS       96     DEFINED      68
   423  RDZ         REAL                              REFS       96     DEFINED      69
   453  RMISS       REAL                C             REFS       24        95     DEFINED      73
   434  RNSTRT    * REAL                              REFS       82
   404  RXFP        REAL                              REFS       49        65       105     DEFINED      46
   455  RYF         REAL                C             REFS       24        73        97     DEFINED      70
   405  RYFP        REAL                              REFS       70       105     DEFINED      47
   456  RZF         REAL                C             REFS       24        73        97     DEFINED      71
   406  RZFP        REAL                              REFS       71       107     DEFINED      48
   414  S2          REAL                              REFS       63     DEFINED      60        62
  3717  T           REAL                C             REFS       18        72       101
   412  TCASE       REAL                              REFS       58       2*58       62     DEFINED      56
   413  TCASE1      REAL                              REFS       62     DEFINED      57
   427  TZERO       REAL                              REFS       95     DEFINED      72
   400  UC11        REAL                              REFS       46     DEFINED      42
   401  UC12        REAL                              REFS       46     DEFINED      43
   374  UC13        REAL                              REFS       44        45        46     DEFINED      38
   376  UC21        REAL                              REFS       43        45        47     DEFINED      40
   377  UC22        REAL                              REFS       42        44        47     DEFINED      41
   402  UC31        REAL                              REFS       48     DEFINED      44
   403  UC32        REAL                              REFS       48     DEFINED      45
   375  UC33        REAL                              REFS       42        43        48     DEFINED      39
   420  UDELX       REAL                              REFS      2*67    DEFINED     102
   422  UDELY       REAL                              REFS      2*68    DEFINED     103
   424  UDELZ       REAL                              REFS      2*69    DEFINED     104
   430  UT          REAL                              REFS      2*72    DEFINED     101
   416  UXFP        REAL                              REFS      2*66    DEFINED     105
   425  UYFP        REAL                              REFS      2*70    DEFINED     106
```

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      SUBROUTINE G4          74/74    OPT=1                                   FTN 4.2+74355      07/07/75  11.07.07.       PAGE    5

VARIABLES        SN  TYPE             RELOCATION
    426  UZEP        REAL                                   REFS         2*71    DEFINED       107
    411  VALUE       REAL                                   REFS          54         55    DEFINED         53
   3701  VMEAN       REAL          ARRAY     C              REFS          31         34    DEFINED         58
   3667  VSD         REAL          ARRAY     C              REFS          30         34    DEFINED         63
    436  VSUM        REAL          ARRAY                    REFS          35         54         58         60        62
                                                          DEFINED         54
    450  VSZ         REAL          ARRAY                    REFS          35         55         60         62    DEFINED      55
    435  XMCSPOT     REAL                                   REFS          86    DEFINED         84
    432  YAW         REAL                                   REFS          77    DEFINED         75
   3033  YMC         REAL                    C              REFS          19         85
   3034  YMC2        REAL                    C              REFS          20       2*84         85
   3045  ZMC         REAL                    C              REFS          21         85
   3046  ZMC2        REAL                    C              REFS          22       2*84         86

FILE NAMES         MODE
       TAPE6       FMT                            WRITES          76         77         73         83         85         86         95         96
                                                      97

EXTERNALS             TYPE    ARGS          REFERENCES
       COSD        REAL          1                 39         41
       MCARLX                    3                 82
       SIND        REAL          1                 38         40
       SQRT        REAL          1  LIBRARY        53         73         84

STATEMENT LABELS                  DEF LINE     REFERENCES
     66  2                              62         59
     73  3                              63         61
      0  5                              64         51
    163  10                            101         49
    175  20                            109         37
    152  30                             87         81
    100  50                             65         50
    211  100       FMT                   7         95
    221  200       FMT                   9         96
    231  300       FMT                  11         97
    264  400       FMT                  80         79
    312  500       FMT                  88         83
    251  600       FMT                  78         76         77
    325  2555      FMT                  91         95
    335  2556      FMT                  93         96

LOOPS  LABEL      INDEX        FROM-TO      LENGTH     PROPERTIES
   45  5        * I            51 64         330                   EXT REFS

COMMON BLOCKS     LENGTH      MEMBERS - BIAS NAME(LENGTH)
       C            3830                 0 C        (3830)

EQUIV CLASSES     LENGTH      MEMBERS - BIAS NAME(LENGTH)
C       C           3830                30 LOEP     (1)                    299 RMISS   (1)                    330 L        (1)
                                       301 RYF      (1)                    302 RZF     (1)                    356 BGAMH    (1)
                                       357 BGAMV    (1)                    370 RANGE   (1)                   1553 YMC      (1)
                                      1564 YMC2     (1)                   1573 ZMC     (1)                   1574 ZMC2     (1)
                                      1634 RDELX    (1)                   1635 RDELY   (1)                   1636 RDELZ    (1)
                                      1399 T        (1)                   2019 LCONW   (1)                   2939 VSD      (10)
                                      3009 VMEAN    (10)                  3019 IMVNDX  (10)                  3029 IMVGT    (1)
                                      3720 ITCT     (1)
```

```
STATISTICS
  PROGRAM LENGTH              462B      306
  CM LABELED COMMON LENGTH   7366B     3830
```

```
      SUBROUTINE AMRK(AUXSUB)                                        AMRK     2
      COMMON // C(3830)                                              AMRK     3
      DIMENSION CSAV(100), IPL(100)                                  AMRK     4
      REAL K1(100), K2(100), K3(100), K4(100)                        AMRK     5
      EQUIVALENCE (C(2000),    T)                                    AMRK     6
      EQUIVALENCE (C(2664), DELT)                                    AMRK     7
      EQUIVALENCE (C(1974),    NJ)                                   AMRK     8
      EQUIVALENCE (C(2562),  IPL)                                    AMRK     9
      EQUIVALENCE (C(1975),XWORK)                                    AMRK    10
      XWORK = -1.                                                    AMRK    11
      DO 1 I = 1,NJ                                                  AMRK    12
      J = IPL(I)                                                     AMRK    13
C                                                                    AMRK    14
C****STORE INITIAL VALUES                                            AMRK    15
      CSAV(I) = C(J+3)                                               AMRK    16
C                                                                    AMRK    17
C*** COMPUTE K1                                                      AMRK    18
      K1(I) = DELT*C(J)                                              AMRK    19
    1 C(J+3) = CSAV(I) + .5*K1(I)                                    AMRK    20
      T = T + .5*DELT                                                AMRK    21
      CALL AUXSUB                                                    AMRK    22
C                                                                    AMRK    23
C*** COMPUTE K2                                                      AMRK    24
      DO 2 I = 1,NJ                                                  AMRK    25
      J = IPL(I)                                                     AMRK    26
      K2(I) = DELT*C(J)                                              AMRK    27
    2 C(J+3) = CSAV(I) + .5*K2(I)                                    AMRK    28
      CALL AUXSUB                                                    AMRK    29
C                                                                    AMRK    30
C*** COMPUTE K3                                                      AMRK    31
      DO 3 I = 1,NJ                                                  AMRK    32
      J = IPL(I)                                                     AMRK    33
      K3(I) = DELT*C(J)                                              AMRK    34
    3 C(J+3) = CSAV(I) + K3(I)                                       AMRK    35
      T = T + .5*DELT                                                AMRK    36
      CALL AUXSUB                                                    AMRK    37
C                                                                    AMRK    38
C*** COMPUTE K4                                                      AMRK    39
      DO 4 I = 1, NJ                                                 AMRK    40
      J = IPL(I)                                                     AMRK    41
      K4(I) = DELT*C(J)                                              AMRK    42
    4 C(J+3) = CSAV(I) +(K1(I) + 2.*(K2(I) + K3(I)) + K4(I))/6.      AMRK    43
      XWORK = 1.                                                     AMRK    44
      CALL AUXSUB                                                    AMRK    45
      RETURN                                                         AMRK    46
      END                                                            AMRK    47
```

CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
19	I	NJ	THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.
27	I	NJ	THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.
34	I	NJ	THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.
42	I	NJ	THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.

```
      SUBROUTINE AMRK       74/74   OPT=1                          FTN 4.2+74355        07/07/75  11.07.10.        PAGE     3

      SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS      DEF LINE      REFERENCES
  .   3 AMRK           1            45

 VARIABLES        SN  TYPE              RELOCATION
      0 C             REAL       ARRAY     C          REFS        2         5         6         7         8         9        15
                                                        18       26        33        41   DEFINED        19        27        34
                                                        42
    114 CSAV          REAL       ARRAY                REFS        3        19        27        34        42
                                                   DEFINED       15
   5147 DELT          REAL                 C          REFS        6        18        20        26        33        35        41
    112 I             INTEGER                         REFS       12        13        18      2*19        25        26      2*27
                                                        32       33      2*34        40        41      5*42
                                                   DEFINED       11        24        31        39
   5001 IPL           INTEGER    ARRAY     C          REFS        3         8        12        25        32        40
    113 J             INTEGER                         REFS       15        18        19        26        27        33        34
                                                        41       42   DEFINED        12        25        32        40
    260 K1            REAL       ARRAY                REFS        4        19        42   DEFINED        18
    424 K2            REAL       ARRAY                REFS        4        27        42   DEFINED        26
    570 K3            REAL       ARRAY                REFS        4        34        42   DEFINED        33
    734 K4            REAL       ARRAY                REFS        4        42   DEFINED        41
   3665 NJ            INTEGER              C          REFS        7        11        24        31        39
   3717 T             REAL                 C          REFS        5        20        35   DEFINED        20        35
   3667 XNORK         REAL                 C          REFS        9   DEFINED        18        43

 EXTERNALS            TYPE    ARGS         REFERENCES
       AUXSUB                   0    F.P.      21        28        36        44

 STATEMENT LABELS                    DEF LINE    REFERENCES
      0 1                               19           11
      0 2                               27           24
      0 3                               34           31
      0 4                               42           39

 LOOPS  LABEL       INDEX       FROM-TO      LENGTH      PROPERTIES
    23  1             I          11 19         64         INSTACK
    41  2             I          24 27         63         INSTACK
    54  3             I          31 34         58         INSTACK
    70  4             I          39 42        113           OPT

 COMMON BLOCKS     LENGTH       MEMBERS - BIAS NAME(LENGTH)
       C            3830                     0 C        (3830)

 EQUIV CLASSES     LENGTH       MEMBERS - BIAS NAME(LENGTH)
 C      C           3830               1973 NJ      (1)             1975 XNORK   (1)                1939 T        (1)
                                       2561 IPL     (100)           2663 DELT    (1)

 STATISTICS
   PROGRAM LENGTH                   11058     581
   CM LABELED COMMON LENGTH         73668    3830
```

```
SUBROUTINE AUXI        74/74    OPT=1                          FTN 4.2+74355       07/07/75  11.07.11.        PAGE    1

      SUBROUTINE AUXI                                                   AMRK     48
      COMMON /C/ C(3830)                                                AMRK     49
      EQUIVALENCE (C(2361),NOMOD ), (C(2362),XMODNO), (C(2561),N      ) AMRK     50
      DIMENSION  XMODNO(99)                                             AMRK     51
      N = 1                                                             AMRK     52
      DO 1 I=1,NOMOD                                                    AMRK     53
      L =XMODNO(I)                                                      AMRK     54
      GO TO (1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23 AMRK     55
     1 ,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38),L                 AMRK     56
    2 CALL A1I                                                          AMRK     57
      GO TO 1                                                           AMRK     58
    3 CALL A2I                                                          AMRK     59
      GO TO 1                                                           AMRK     60
    4 CALL A3I                                                          AMRK     61
      GO TO 1                                                           AMRK     62
    5 CALL A4I                                                          AMRK     63
      GO TO 1                                                           AMRK     64
    6 CALL A5I                                                          AMRK     65
      GO TO 1                                                           AMRK     66
    7 CALL C1I                                                          AMRK     67
      GO TO 1                                                           AMRK     68
    8 CALL C2I                                                          AMRK     69
      GO TO 1                                                           AMRK     70
    9 CALL C3I                                                          AMRK     71
      GO TO 1                                                           AMRK     72
   10 CALL C4I                                                          AMRK     73
      GO TO 1                                                           AMRK     74
   11 CALL C5I                                                          AMRK     75
      GO TO 1                                                           AMRK     76
   12 CALL C6I                                                          AMRK     77
      GO TO 1                                                           AMRK     78
   13 CALL C7I                                                          AMRK     79
      GO TO 1                                                           AMRK     80
   14 CALL C8I                                                          AMRK     81
      GO TO 1                                                           AMRK     82
   15 CALL C9I                                                          AMRK     83
      GO TO 1                                                           AMRK     84
   16 CALL C10I                                                         AMRK     85
      GO TO 1                                                           AMRK     86
   17 CALL D1I                                                          AMRK     87
      GO TO 1                                                           AMRK     88
   18 CALL D2I                                                          AMRK     89
      GO TO 1                                                           AMRK     90
   19 CALL D3I                                                          AMRK     91
      GO TO 1                                                           AMRK     92
   20 CALL D4I                                                          AMRK     93
      GO TO 1                                                           AMRK     94
   21 CALL D5I                                                          AMRK     95
      GO TO 1                                                           AMRK     96
   22 CALL G1I                                                          AMRK     97
      GO TO 1                                                           AMRK     98
   23 CALL G2I                                                          AMRK     99
      GO TO 1                                                           AMRK    100
   24 CALL G3I                                                          AMRK    101
      GO TO 1                                                           AMRK    102
   25 CALL G4I                                                          AMRK    103
      GO TO 1                                                           AMRK    104
```

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      SUBROUTINE AUXI        74/74    OPT=1                    FTN 4.2+74355      07/07/76  11.07.11.       PAGE    2

   26 CALL G5I                                                                    AMRK   105
      GO TO 1                                                                     AMRK   106
   27 CALL G6I                                                                    AMRK   107
      GO TO 1                                                                     AMRK   108
   28 CALL S1I                                                                    AMRK   109
      GO TO 1                                                                     AMRK   110
   29 CALL S2I                                                                    AMRK   111
      GO TO 1                                                                     AMRK   112
   30 CALL S3I                                                                    AMRK   113
      GO TO 1                                                                     AMRK   114
   31 CALL S4I                                                                    AMRK   115
      GO TO 1                                                                     AMRK   116
   32 CALL S5I                                                                    AMRK   117
      GO TO 1                                                                     AMRK   118
   33 CALL S6I                                                                    AMRK   119
      GO TO 1                                                                     AMRK   120
   34 CALL S7I                                                                    AMRK   121
      GO TO 1                                                                     AMRK   122
   35 CALL S8I                                                                    AMRK   123
      GO TO 1                                                                     AMRK   124
   36 CALL S9I                                                                    AMRK   125
      GO TO 1                                                                     AMRK   126
   37 CALL S10I                                                                   AMRK   127
      GO TO 1                                                                     AMRK   128
   38 CALL SPOTI                                                                  AMRK   129
    1 CONTINUE                                                                    AMRK   130
      RETURN                                                                      AMRK   131
      END                                                                         AMRK   132
```

```
     SUBROUTINE AUXI        74/74    OPT=1                                FTN 4.2+74355       07/07/75  11.07.11.       PAGE      3

            SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS       DEF LINE       REFERENCES
     1  AUXI             1            84

 VARIABLES         SN  TYPE              RELOCATION
       0  C             REAL         ARRAY    C                REFS          2         3*3
     174  I             INTEGER                                REFS          7     DEFINED          6
     175  L             INTEGER                                REFS          8     DEFINED          7
    5000  N             INTEGER                   C            REFS          3     DEFINED          5
    4470  NOMOD         INTEGER                   C            REFS          3          5
    4471  XMODNO        REAL         ARRAY        C            REFS          3          4           7

 EXTERNALS              TYPE    ARGS        REFERENCES
           A1I                    0              10
           A2I                    0              12
           A3I                    0              14
           A4I                    0              16
           A5I                    0              18
           C1I                    0              20
           C10I                   0              38
           C2I                    0              22
           C3I                    0              24
           C4I                    0              26
           C5I                    0              28
           C6I                    0              30
           C7I                    0              32
           C8I                    0              34
           C9I                    0              36
           D1I                    0              40
           D2I                    0              42
           D3I                    0              44
           D4I                    0              46
           D5I                    0              48
           G1I                    0              50
           G2I                    0              52
           G3I                    0              54
           G4I                    0              56
           G5I                    0              58
           G6I                    0              60
           SPOTI                  0              82
           S1I                    0              62
           S10I                   0              80
           S2I                    0              64
           S3I                    0              66
           S4I                    0              68
           S5I                    0              70
           S6I                    0              72
           S7I                    0              74
           S8I                    0              76
           S9I                    0              78

 STATEMENT LABELS                DEF LINE     REFERENCES
   171  1                           83           6         8        11        13        15        17        19        21        23
                                                25        27        29        31        33        35        37        39        41
                                                43        45        47        49        51        53        55        57        59
                                                61        63        65        67        69        71        73        75        77
```

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        SUBROUTINE AUXI         74/74    OPT=1                            FTN 4.2+74355       07/07/75   11.07.11.        PAGE      4

  STATEMENT LABELS                      DEF LINE    REFERENCES
                                                       79         81
     60  2                                 10          8
     62  3                                 12          8
     64  4                                 14          8
     66  5                                 16          8
     70  6                                 18          8
     72  7                                 20          8
     74  8                                 22          8
     76  9                                 24          8
    100  10                                26          8
    102  11                                28          8
    104  12                                30          8
    106  13                                32          8
    110  14                                34          8
    112  15                                36          8
    114  16                                38          8
    116  17                                40          8
    120  18                                42          8
    122  19                                44          8
    124  20                                46          8
    126  21                                48          8
    130  22                                50          8
    132  23                                52          8
    134  24                                54          8
    136  25                                56          8
    140  26                                58          8
    142  27                                60          8
    144  28                                62          8
    146  29                                64          8
    150  30                                66          8
    152  31                                68          8
    154  32                                70          8
    156  33                                72          8
    160  34                                74          8
    162  35                                76          8
    164  36                                78          8
    166  37                                80          8
    170  38                                82          8

  LOOPS  LABEL     INDEX       FROM-TO      LENGTH     PROPERTIES
     4   1        * I            6 83        170B                 EXT REFS

  COMMON BLOCKS    LENGTH       MEMBERS - BIAS NAME(LENGTH)
         C          3830                  0 C        (3830)

  EQUIV CLASSES    LENGTH       MEMBERS - BIAS NAME(LENGTH)
  C      C          3830             2360 NOMOD  (1)                  2361 XMODMD (99)              2550 N        (1)

  STATISTICS
    PROGRAM LENGTH                  176B      126
    CM LABELED COMMON LENGTH      7366B      3830
```

```
      SUBROUTINE AUXSUB                                                 AMRK     133
      COMMON /C/ C(3030)                                                AMRK     134
      EQUIVALENCE (C(2000),T      ), (C(2361),NOMOD ), (C(2362),XMODNO) AMRK     135
      EQUIVALENCE (C(2561),N      ), (C(2562),IPL   ), (C(2664),DER   ) AMRK     136
      EQUIVALENCE (C(2965),VAR    )                                     AMRK     137
      EQUIVALENCE (C(2020),.CONV)                                       AMRK     138
      DIMENSION   DER(101)         , VAR(101)        , IPL(100)         AMRK     139
      DIMENSION   XMODNO(99)                                            AMRK     140
      EXTERNAL A1                                                       AMRK     141
      EXTERNAL A2                                                       AMRK     142
      EXTERNAL A3                                                       AMRK     143
      DO 1 I=1,NOMOD                                                    AMRK     144
      IF(.CONV.EQ.2)RETURN                                              AMRK     145
      L =XMODNO(I)                                                      AMRK     146
      GO TO (1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,  AMRK     147
     1  23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38),L              AMRK     148
    2 CALL A1                                                           AMRK     149
      GO TO 1                                                           AMRK     150
    3 CALL A2                                                           AMRK     151
      GO TO 1                                                           AMRK     152
    4 CALL A3                                                           AMRK     153
      GO TO 1                                                           AMRK     154
    5 CALL A4                                                           AMRK     155
      GO TO 1                                                           AMRK     156
    6 CALL A5                                                           AMRK     157
      GO TO 1                                                           AMRK     158
    7 CALL C1                                                           AMRK     159
      GO TO 1                                                           AMRK     160
    8 CALL C2                                                           AMRK     161
      GO TO 1                                                           AMRK     162
    9 CALL C3                                                           AMRK     163
      GO TO 1                                                           AMRK     164
   10 CALL C4                                                           AMRK     165
      GO TO 1                                                           AMRK     166
   11 CALL C5                                                           AMRK     167
      GO TO 1                                                           AMRK     168
   12 CALL C6                                                           AMRK     169
      GO TO 1                                                           AMRK     170
   13 CALL C7                                                           AMRK     171
      GO TO 1                                                           AMRK     172
   14 CALL C8                                                           AMRK     173
      GO TO 1                                                           AMRK     174
   15 CALL C9                                                           AMRK     175
      GO TO 1                                                           AMRK     176
   16 CALL C10                                                          AMRK     177
      GO TO 1                                                           AMRK     178
   17 CALL D1                                                           AMRK     179
      GO TO 1                                                           AMRK     180
   18 CALL D2                                                           AMRK     181
      GO TO 1                                                           AMRK     182
   19 CALL D3                                                           AMRK     183
      GO TO 1                                                           AMRK     184
   20 CALL D4                                                           AMRK     185
      GO TO 1                                                           AMRK     186
   21 CALL D5                                                           AMRK     187
      GO TO 1                                                           AMRK     188
   22 CALL G1                                                           AMRK     189
```

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                GO TO 1                                                  AMRK    190
             23 CALL G2                                                  AMRK    191
                GO TO 1                                                  AMRK    192
             24 CALL G3                                                  AMRK    193
                GO TO 1                                                  AMRK    194
             25 CALL G4                                                  AMRK    195
                GO TO 1                                                  AMRK    196
             26 CALL G5                                                  AMRK    197
                GO TO 1                                                  AMRK    198
             27 CALL G6                                                  AMRK    199
                GO TO 1                                                  AMRK    200
             28 CALL S1                                                  AMRK    201
                GO TO 1                                                  AMRK    202
             29 CALL S2                                                  AMRK    203
                GO TO 1                                                  AMRK    204
             30 CALL S3                                                  AMRK    205
                GO TO 1                                                  AMRK    206
             31 CALL S4                                                  AMRK    207
                GO TO 1                                                  AMRK    208
             32 CALL S5                                                  AMRK    209
                GO TO 1                                                  AMRK    210
             33 CALL S6                                                  AMRK    211
                GO TO 1                                                  AMRK    212
             34 CALL S7                                                  AMRK    213
                GO TO 1                                                  AMRK    214
             35 CALL S8                                                  AMRK    215
                GO TO 1                                                  AMRK    216
             36 CALL S9                                                  AMRK    217
                GO TO 1                                                  AMRK    218
             37 CALL S10                                                 AMRK    219
                GO TO 1                                                  AMRK    220
          38    CALL SHOT                                                AMRK    221
              1 CONTINUE                                                 AMRK    222
                RETURN                                                   AMRK    223
                END                                                      AMRK    224
```

```
      SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE     REFERENCES
   1  AUXSUB          1           13         91

VARIABLES       SN  TYPE            RELOCATION
     0  C            REAL      ARRAY    C           REFS        2      3*3      3*4      5      6
  5147  DER          REAL      ARRAY    C           REFS        4        7
   175  I            INTEGER                        REFS       14   DEFINED     12
  5001  IPL          INTEGER   ARRAY    C           REFS        4        7
   176  L            INTEGER                        REFS       15   DEFINED     14
  3743  LCONV        INTEGER            C           REFS        6       13
  5000  N            INTEGER            C           REFS        4
  4470  NOMOD        INTEGER            C           REFS        3       12
  3717  T            REAL               C           REFS        3
  5624  VAR          REAL      ARRAY    C           REFS        5        7
  4471  XMODNO       REAL      ARRAY    C           REFS        3        9       14

EXTERNALS            TYPE   ARGS        REFERENCES
        A1                    0              9        17
        A2                    0             10        19
        A3                    0             11        21
        A4                    0             23
        A5                    0             25
        C1                    0             27
        C10                   0             45
        C2                    0             29
        C3                    0             31
        C4                    0             33
        C5                    0             35
        C6                    0             37
        C7                    0             39
        C8                    0             41
        C9                    0             43
        D1                    0             47
        D2                    0             49
        D3                    0             51
        D4                    0             53
        D5                    0             55
        G1                    0             57
        G2                    0             59
        G3                    0             61
        G4                    0             63
        G5                    0             65
        G6                    0             67
        SPOT                  0             89
        S1                    0             69
        S10                   0             87
        S2                    0             71
        S3                    0             73
        S4                    0             75
        S5                    0             77
        S6                    0             79
        S7                    0             81
        S8                    0             83
        S9                    0             85
```

```
      SUBROUTINE AUXSUB     74/74    OPT=1                            FTN 4.2+74353      07/07/76  11.07.13.       PAGE     4

  STATEMENT LABELS                     DEF LINE   REFERENCES
    172  1                                90        12        15        18        20        22        24        26        28        30
                                                    32        34        36        38        40        42        44        46        48
                                                    50        52        54        56        58        60        62        64        66
                                                    68        70        72        74        76        78        80        82        84
                                                    86        89
     61  2                                17        15
     63  3                                19        15
     65  4                                21        15
     67  5                                23        15
     71  6                                25        15
     73  7                                27        15
     75  8                                29        15
     77  9                                31        15
    101  10                               33        15
    103  11                               35        15
    105  12                               37        15
    107  13                               39        15
    111  14                               41        15
    113  15                               43        15
    115  16                               45        15
    117  17                               47        15
    121  18                               49        15
    123  19                               51        15
    125  20                               53        15
    127  21                               55        15
    131  22                               57        15
    133  23                               59        15
    135  24                               61        15
    137  25                               63        15
    141  26                               65        15
    143  27                               67        15
    145  28                               69        15
    147  29                               71        15
    151  30                               73        15
    153  31                               75        15
    155  32                               77        15
    157  33                               79        15
    161  34                               81        15
    163  35                               83        15
    165  36                               85        15
    167  37                               87        15
    171  38                               89        15

  LOOPS  LABEL     INDEX      FROM-TO      LENGTH      PROPERTIES
     3   1        * I          12 90        172B                  EXT REFS     EXITS

  COMMON BLOCKS    LENGTH      MEMBERS - BIAS NAME(LENGTH)
        C           3830                   0 C      (3830)

  EQUIV CLASSES    LENGTH      MEMBERS - BIAS NAME(LENGTH)
  C     C           3830             1999 T       (1)                2019 LGOMA   (1)                 2350 NOMOD   (1)
                                     2361 XMODNO  (99)               2560 N       (1)                 2551 IPL     (100)
                                     2663 DER     (101)              2964 VAR     (101)

  STATISTICS
    PROGRAM LENGTH                  177B      127
    CM LABELED COMMON LENGTH      7366B      3830
```

```
      SUBROUTINE DUMPO                                              AMRK   225
      COMMON /C/ C(3830)                                            AMRK   226
      DO 100 I=1, 1800, 7                                           AMRK   227
      N = 0                                                         AMRK   228
      DO 200 J=1, 7                                                 AMRK   229
      K = I + J - 1                                                 AMRK   230
  200 IF (ABS(C(K)) .GT. 1.E-10) N = 1                              AMRK   231
  100 IF (N .GT. 0) WRITE(6,300)                                    AMRK   232
     *   I,C(I),C(I+1),C(I+2),C(I+3),C(I+4),C(I+5),C(I+6)           AMRK   233
  300 FORMAT(1H ,I5,1P7E15.7)                                       AMRK   234
      RETURN                                                        AMRK   235
      END                                                           AMRK   236
```

```
      SUBROUTINE DUMPO       74/74    OPT=1                                FTN 4.2+74355        07/07/75  11.07.15.       PAGE     2

      SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS        DEF LINE      REFERENCES
     1  DUMPO             1           11

 VARIABLES       SN  TYPE               RELOCATION
     0  C             REAL          ARRAY    C              REFS        2          7         7*8
    57  I             INTEGER                               REFS        6        8*8    DEFINED         3
    61  J             INTEGER                               REFS        6    DEFINED         5
    62  K             INTEGER                               REFS        7    DEFINED         6
    60  M             INTEGER                               REFS        8    DEFINED         4          7

 FILE NAMES          MODE
        TAPE6        FMT                      WRITES        8

 INLINE FUNCTIONS     TYPE    ARGS         DEF LINE   REFERENCES
        ABS           REAL      1  INTRIN                    7

 STATEMENT LABELS                   DEF LINE    REFERENCES
     0  100                             8          3
     0  200                             7          5
    53  300        FMT                 10          8

 LOOPS  LABEL      INDEX      FROM-TO       LENGTH     PROPERTIES
     3  100      * I           3 9           35B                   EXT REFS  NOT INNER
    11  200      * J           5 7           7B        INSTACK

 COMMON BLOCKS     LENGTH       MEMBERS - BIAS  NAME(LENGTH)
        C          3830                   0 C       (3830)

 STATISTICS
   PROGRAM LENGTH                   63B       51
   CM LABELED COMMON LENGTH       7366B     3830
```

```
      SUBROUTINE OINPT1                                                 IO        2
C     BASIC INPUT SUBROUTINE OINPT1                                     IO        3
      COMMON /C/ C(3830)                                                IO        4
      EQUIVALENCE (C(3218),ONAME1), (C(3268),ONAME2), (C(3318),ONAME3), IO        5
C                 (C(3328),ONAME4), (C(2361),NOMOD ), (C(2362),MODNO ), IO        6
C                 (C(3168),OUTNO ), (C(2461),NOSUB ), (C(2462),SUBNO ), IO        7
C(C(3068),NOLIST),(C(3167),NOOUT),                                      IO        8
C                 (C(3867),LISTNO), (C(3117),VALUE ), (C(2008),PLOTNO), IO        9
C                 (C(2009),NOPLOT), (C(2325),VLABLE), (D,K)             IO       10
      EQUIVALENCE (C(2010),   STEP)                                     IO       11
      EQUIVALENCE (C(1984),VPLOT )                                      IO       12
      EQUIVALENCE (C(1985),OUTPLT)                                      IO       13
      EQUIVALENCE (C(3512),ISGCT),(C(3514),SIGMA),(C(3554),SIGLB),      IO       14
     *(C(3594),SIGUB),(C(3634),ISNDX),(C(3674),IDIST),(C(3598),RNSTRT)  IO       15
      EQUIVALENCE(C(3721),ITCT),(C(3723),TSGMA),(C(3733),TLB),          IO       16
     *(C(3743),TUB),(C(3753),ITNDX),(C(3763),ITDIST),(C(3773),TSPER),   IO       17
     *(C(3783),TYPPER),(C(3793),TPSIG),(C(3803),TNXST),(C(3813),ITNDX2) IO       18
      EQUIVALENCE (C( 21),IBVNSW)                                       IO       19
      EQUIVALENCE (C( 22), IPLOT)                                       IO       20
      EQUIVALENCE (C(19),PSIZE)                                         IO       21
      EQUIVALENCE (C( 23),XLAMBD)                                       IO       22
      EQUIVALENCE (C( 24), KSSIG)                                       IO       23
      EQUIVALENCE (C( 25),CEPSIG)                                       IO       24
      EQUIVALENCE (C(3825),  NCASE)                                     IO       25
      EQUIVALENCE (C(3020),IMVNDX)                                      IO       26
      EQUIVALENCE (C(3030),IMVCT )                                      IO       27
      DIMENSION ISCALE(15),YMAX(15),YMIN(15)                            IO       28
      EQUIVALENCE (C(1901),ISCALE),(C(1916),YMAX),(C(1931),YMIN)        IO       29
      DIMENSION ONAME3(10),ONAME4(10)                                   IO       30
      DIMENSION LISTNO(50), VALUE(50)                                   IO       31
      DIMENSION SUBNO(99),IR(4),VR(4)                                   IO       32
      DIMENSION ALPHA(3),ONAME1(50),ONAME2(50),OUTNO(50) ,MODNO(99)     IO       33
      DIMENSION K(3510)                                                 IO       34
      DIMENSION VLABLE(2,15)                                            IO       35
      DIMENSION OUTPLT(15)                                              IO       36
      DIMENSION SIGMA(40),SIGLB(40),SIGUB(40),ISNDX(40),IDIST(40)       IO       37
      DIMENSION TSGMA(10),TLB(10),TUB(10),ITNDX(10),ITDIST(10),         IO       38
     *TSPER(10),TYPPER(10),TPSIG(10),ITNDX2(10),TNXST(10)               IO       39
      DIMENSION IMVNDX(10)                                              IO       40
      DIMENSION CEPSIG(6)                                               IO       41
      INTEGER CEPSIG                                                    IO       42
      REAL KSSIG                                                        IO       43
      REAL MODNO                                                        IO       44
      INTEGER OUTNO                                                     IO       45
      INTEGER OUTPLT                                                    IO       46
      DIMENSION COEFF(28),REF(28),BREF(28),ATD(5),BATD(5),DTA(4),BDTA(4) IO      47
      EQUIVALENCE (C(3359),COEFF)                                       IO       48
      EQUIVALENCE (C(3387),REF)                                         IO       49
      EQUIVALENCE (C(3415),BREF)                                        IO       50
      EQUIVALENCE (C(3443),ATD)                                         IO       51
      EQUIVALENCE (C(3448),BATD)                                        IO       52
      EQUIVALENCE (C(3453),DTA)                                         IO       53
      EQUIVALENCE (C(3457),BDTA)                                        IO       54
      NAMELIST /DAP/COEFF,REF,BREF,ATD,BATD,DTA,BDTA                    IO       55
      DATA OPERTY/10HR         /                                        IO       56
      DATA SSS/10HS          /                                          IO       57
      DATA IFLAG/0/                                                     EXCEED    4
```

```
      IF(IFLAG .LE. 0) GO TO 200                                           EXCEE)     5
      WRITE(6,201)                                                         EXCEE)     6
  201 FORMAT(1H0,*RESET DATA ARRAY EXCEEDED DURING LAST RUN.*//            EXCEE)     7
     11H ,40H**********ABNORMAL TERMINATION**********//)                   EXCEE)     8
      CALL EXIT                                                            EXCEE)     9
      STOP                                                                 EXCEE)    10
  200 CONTINUE                                                             EXCEE)    11
      JAR = 0                                                              IO        58
      WRITE(6,31)                                                          IO        59
   31 FORMAT(11H1INPUT DATA/)                                              IO        60
    1 READ(5,2)IR(1),(ALPHA(JC),JC=1,3),IR(2),IR(3),TPER,TPSGMA,           IO        61
     *VR(1),VR(2),VR(3),IR(4),VR(4)                                        IO        62
      IF(EOF(5)) 50,55                                                     IO        63
   55 CONTINUE                                                             IO        64
      WRITE(6,30)IR(1),(ALPHA(JC),JC=1,3),IR(2),IR(3),TPER,TPSGMA,         IO        65
     *VR(1),VR(2),VR(3),                                                   IO        66
     *IR(4),VR(4)                                                          IO        67
   30 FORMAT(1X,I2,3A6,I5,I2,A1,F5.2,2E15.7,F10.4,I5,F7.4)                 IO        68
    2 FORMAT(I2,3A6,I5,I1,A1,F3.2,2E15.7,F10.4,I5,F5.2)                    IO        69
    7 IF( IR(1) .NE. 1 )  GO TO 3                                          IO        70
      NOSUB = NOSUB + 1                                                    IO        71
      SUBNO(NOSUB) = IR(2)                                                 IO        72
      GO TO 1                                                              IO        73
    3 IF( IR(1) .NE. 2 )  GO TO 4                                          IO        74
      NOMOD = NOMOD + 1                                                    IO        75
      MODNO(NOMOD) = IR(2)                                                 IO        76
      GO TO 1                                                              IO        77
    4 IF(IR(1) .NE. 3) GO TO 5                                             IO        78
      L = IR(2)                                                            IO        79
      C(L) = VR(1)                                                         IO        80
      IF (VR(2) .EQ. 0.) GO TO 1                                           IO        81
      IF(NOLIST .LE. 49) GO TO 10                                          EXCEE)    12
      WRITE(6,109) (ALPHA(I),I=1,3),IR(2)                                  EXCEE)    13
  109 FORMAT(1H0,*RESET VARIABLE LIST EXCEEDED *3A6,* C-LOCATION *I5,      EXCEE)    14
     1* EXCLUDED FROM RESET LIST*)                                         EXCEE)    15
      IFLAG = 1                                                            EXCEE)    16
      GO TO 1                                                              EXCEE)    17
   10 CONTINUE                                                             EXCEE)    18
      NOLIST = NOLIST + 1                                                  IO        82
      LISTNO(NOLIST) = L                                                   IO        83
      VALUE(NOLIST) = VR(1)                                                IO        84
      GO TO 1                                                              IO        85
    5 IF(IR(1) .NE. 4)GO TO 6                                              IO        86
      IF(NOOUT .LE. 49) GO TO 12                                           EXCEE)    19
      WRITE(6,11) (ALPHA(I),I=1,3),IR(2)                                   EXCEE)    20
   11 FORMAT(1H0,*OUTPUT LIST EXCEEDED *,3A6,* C-LOCATION *I5              EXCEE)    21
     1,* EXCLUDED FROM OUTPUT LIST*)                                       EXCEE)    22
      GO TO 1                                                              EXCEE)    23
   12 CONTINUE                                                             EXCEE)    24
      NOOUT = NOOUT + 1                                                    IO        87
      IF (NOOUT.GT.50) GO TO 1                                             IO        88
      ONAME1(NOOUT)=ALPHA(2)                                               IO        89
      ONAME2(NOOUT) = ALPHA(3)                                             IO        90
      OUTNO(NOOUT) = IR(2)                                                 IO        91
      GO TO 1                                                              IO        92
    6 IF (IR(1) .NE. 5) GO TO 16                                           IO        93
      READ(5,DAP)                                                          IO        94
```

```
                  WRITE(6,DAP)                                                      IO        95
                  GO TO 1                                                           IO        96
               16 IF (IR(1).NE.7) GO TO 19                                          IO        97
                  IF(NPLOT .LE. 14) GO TO 14                                        EXCEED    25
                  WRITE(6,13) (ALPHA(I),I=1,3),IR(2)                                EXCEED    26
               13 FORMAT(1H0,*PLOT LIST EXCEEDED *3A6* C-LOCATION *,I5,             EXCEED    27
                 1* EXCLUDED FROM PLOT LIST*)                                       EXCEED    28
                  GO TO 1                                                           EXCEED    29
               14 CONTINUE                                                          EXCEED    30
                  NPLOT=NPLOT+1                                                     IO        98
                  IF (NPLOT.GT.15) GO TO 1                                          IO        99
                  DECODE(1,9,TPER)ISCALE(NPLOT)                                     IO        100
                9 FORMAT(I1)                                                        IO        101
                  YMAX(NPLOT)=VR(1)    $    YMIN(NPLOT)=VR(2)                       IO        102
                  DO 20 I=1,2                                                       IO        103
               20 VLABLE (I,NPLOT)=ALPHA(I+1)                                       IO        104
                  OUTPLT(NPLOT)=IR(2)                                               IO        105
                  GO TO 1                                                           IO        106
               19 IF(IR(1).NE.8) GO TO 18                                           IO        107
                  IF(TPER.EQ.SSS) GO TO 194                                         IO        108
                  IF(VR(4).GT.0.) GO TO 192                                         IO        109
                  IF(IR(3).NE.0.AND).IR(3).NE.1) GO TO 193                          IO        110
                  IF(ISGCT .LE. 39) GO TO 22                                        EXCEED    31
                  WRITE(6,21) (ALPHA(I),I=1,3),IR(2)                                EXCEED    32
               21 FORMAT(1H0,*INITIAL CONDITION M. C. VARIABLE LIST EXCEEDED*3A6,   EXCEED    33
                 1* C-LOCATION *I5* EXCLUDED FROM LIST*)                            EXCEED    34
                  GO TO 1                                                           EXCEED    35
               22 CONTINUE                                                          EXCEED    36
                  ISGCT=ISGCT+1                                                     IO        111
                  SIGMA(ISGCT)=VR(1)                                                IO        112
                  SIGLB(ISGCT)=VR(2)                                                IO        113
                  SIGUB(ISGCT)=VR(3)                                                IO        114
                  ISNDX(ISGCT)=IR(2)                                                IO        115
                  IDIST(ISGCT)=IR(3)                                                IO        116
                  GO TO 1                                                           IO        117
               18 IF(IR(1) .NE. 9) GO TO 100                                        IO        118
                  STEP = 11.                                                        IO        119
                  READ(5,8)NP,IBVNSW,IPLOT,XLAMBD,KSSIG,(CEPSIG(I),I=1,5),PSIZE     IO        120
                8 FORMAT(3I4,2F10.3,5I2,E15.7)                                      IO        121
                  GO TO 1                                                           IO        122
              100 IF(IR(1) .NE. 10) GO TO 191                                       IO        123
                  IF(IMVCT .LE. 9) GO TO 108                                        EXCEED    37
                  WRITE(6,107) (ALPHA(I),I=1,3),IR(2)                               EXCEED    38
              107 FORMAT(1H0,*MEAN AND STD. DEV. VARIABLE LIST EXCEEDED *3A6,       EXCEED    39
                 1* C-LOCATION *I5* EXCLUDED FROM LIST*)                            EXCEED    40
                  GO TO 1                                                           EXCEED    41
              108 CONTINUE                                                          EXCEED    42
                  IMVCT = IMVCT + 1                                                 IO        124
                  IMVNDX(IMVCT) = IR(2)                                             IO        125
                  GO TO 1                                                           IO        126
              192 IF(IR(3).GT.5) GO TO 193                                          IO        127
                  IF(ITCT .LE. 9) GO TO 105                                         EXCEED    43
                  WRITE(6,104) (ALPHA(I),I=1,3),IR(2)                               EXCEED    44
              104 FORMAT(1H0,*TIME SERIES M. C. VARIABLE LIST EXCEEDED*3A6,         EXCEED    45
                 1* C-LOCATION *I5* EXCLUDED FROM LIST*)                            EXCEED    46
                  GO TO 1                                                           EXCEED    47
              105 CONTINUE                                                          EXCEED    48
```

```
      ITCT=ITCT+1
      TSGMA(ITCT)=VR(1)
      TLB(ITCT)=VR(2)
      TUB(ITCT)=VR(3)
      ITNDX2(ITCT)=IR(2)
      IF(IR(4).GT.0) ITNDX2(ITCT)=IR(4)
      ITNDX(ITCT)=IR(2)
      ITDIST(ITCT)=IR(3)
      TSPER(ITCT)=VR(4)
      TPSIG(ITCT)=TPSGMA
      TYPPER(ITCT)=0.
      IF(TPER.EQ.CPERTY) TYPPER(ITCT)=1.
      GO TO 1
  194 RNSTRT=VR(1)
      GO TO 1
  193 WRITE(6,5518)
 5518 FORMAT(1X,58HUNDEFINED DISTRIBUTION TYPE NUMBER ENTERED - CARD REJ
     *ECTED)
      WRITE(6,30)IR(1),(ALPHA(JC),JC=1,3),IR(2),IR(3),TPER,TPSGMA,
     *VR(1),VR(2),VR(3),
     *IR(4),VR(4)
      GO TO 1
  191 CONTINUE
      NCASE=NCASE+1
      RETURN
   50 STOP
      END
```

```
      SUBROUTINE DINPT1     74/74    OPT=1                         FTN 4.2+74355       07/07/75  11.07.16.       PAGE      5

CARD NR. SEVERITY  DETAILS     DIAGNOSIS OF PROBLEM

     76     I       33 CD 76  FIELD WIDTH OF A CONVERSION DESCRIPTOR SHOULD BE AS LARGE AS THE MINIMUM SPECIFIED FOR THAT DESCRIPTOR.
```

```
SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE     REFERENCES
   1  OINPT1          1          196

VARIABLES        SN  TYPE             RELOCATION
   690  ALPHA        REAL        ARRAY              REFS        32       72       90      102      109      110      119
                                                     130       138      157      167      190  DEFINED       68
  5562  ATD          REAL        ARRAY       C      REFS        46       50       54
  5567  BATD         REAL        ARRAY       C      REFS        46       51       54
  5600  BDTA         REAL        ARRAY       C      REFS        46       53       54
  5526  BREF         REAL        ARRAY       C      REFS        46       43       54
     0  C            REAL        ARRAY       C      REFS         3      17*4      10       11       12      7*13    11*15
                                                      18        19       20       21       22       23       24       25
                                                      26      3*28       47       48       49       50       51       52
                                                      53   DEFINED       87
    30  CEPSIG       INTEGER     ARRAY       C      REFS        23       40       41  DEFINED      152
  5436  COEFF        REAL        ARRAY       C      REFS        46       47       54
   301  CPERTY       REAL                           REFS       183  DEFINED       55
  5574  CTA          REAL        ARRAY       C      REFS        46       52       54
   636  I            INTEGER                        REFS        90      102      119    2*130      188      152      157
                                                     167   DEFINED       90      102      119      129      138      152
                                                     157       167
    24  I3VNSW       INTEGER                 C      REFS        18  DEFINED      152
  7131  IDIST        INTEGER     ARRAY       C      REFS        13       35  DEFINED      148
   303  IFLAG        INTEGER                        REFS        58  DEFINED       57       93
  5725  IMVCT        INTEGER                 C      REFS        26      155      162      163  DEFINED      152
  5713  IMVNUX       INTEGER     ARRAY       C      REFS        25       39  DEFINED      163
    25  IPLOT        INTEGER                 C      REFS        19  DEFINED      152
   640  IR           INTEGER     ARRAY              REFS        31     4*72       77       79       81       83       85
                                                      86        90      100      102      111      113      117      119
                                                     131       133    2*136      138      147      148      150      155
                                                     157       163      165      167      176    2*177      178      179
                                                   4*190   DEFINED     4*68
  5554  ISCALE       INTEGER     ARRAY       C      REFS        27       28  DEFINED      126
  5667  ISSCT        INTEGER                 C      REFS        13      137      143      144      145      146      147
                                                     148   DEFINED      143
  7061  ISNDX        INTEGER     ARRAY       C      REFS        13       35  DEFINED      147
  7210  ITCT         INTEGER                 C      REFS        15      165      172      173      174      175      176
                                                     177       178      179      180      181      182      183
                                                 DEFINED       172
  7262  ITDIST       INTEGER     ARRAY       C      REFS        15       37  DEFINED      179
  7250  ITNDX        INTEGER     ARRAY       C      REFS        15       37  DEFINED      178
  7344  ITNDX2       INTEGER     ARRAY       C      REFS        15       37  DEFINED      176      177
   631  JAR        * INTEGER                     DEFINED        65
   632  JC           INTEGER                        REFS        68       72      190  DEFINED       68       72      190
     0  K            INTEGER     ARRAY       C      REFS         4       33
    27  KSSIG        REAL                    C      REFS        22       42  DEFINED      152
   635  L            INTEGER                        REFS        87       97  DEFINED       86
  5772  LISTNO       INTEGER     ARRAY       C      REFS         4       30  DEFINED       97
  4471  MODNO        REAL        ARRAY       C      REFS         4       32       43  DEFINED       83
  7360  NCASE        INTEGER                 C      REFS        24      195  DEFINED      195
  5771  NOLIST       INTEGER                 C      REFS         4       89       96       97       98
                                                 DEFINED        96
  4470  NOMOD        INTEGER                 C      REFS         4       82       83  DEFINED       82
  5136  NOOUT        INTEGER                 C      REFS         4      101      107      108      109      110      111
                                                 DEFINED       107
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     SUBROUTINE OINPT1      74/74    OPT=1                          FTN 4.2+74355       07/07/75  11.07.16.       PAGE    7

VARIABLES        SN  TYPE            RELOCATION
  3730  NOPLOT       INTEGER               C           REFS         4
  4634  NOSUB        INTEGER               C           REFS         4        78        79     DEFINED      79
   637  NP         * INTEGER                        DEFINED       152
  3677  NPLOT        INTEGER               C           REFS        11       123       124       125       126      2*128      130
                                                        131     DEFINED     124
  5221  ONAME1       REAL        ARRAY     C           REFS         4        32    DEFINED      109
  5303  ONAME2       REAL        ARRAY     C           REFS         4        32    DEFINED      110
  5365  ONAME3       REAL        ARRAY     C           REFS         4        23
  5377  ONAME4       REAL        ARRAY     C           REFS         4        23
  5137  OUTNO        INTEGER     ARRAY     C           REFS         4        32        44     DEFINED      111
  3700  OUTPLT       INTEGER     ARRAY     C           REFS        12        35        45     DEFINED      131
  3727  PLOTNO       REAL                  C           REFS         4
    22  PSIZE        REAL                  C           REFS        20    DEFINED      152
  5472  REF          REAL        ARRAY     C           REFS        46        49        54
  3666  RNSTRT       REAL                  C           REFS        13    DEFINED      185
  5741  SIGLB        REAL        ARRAY     C           REFS        13        35    DEFINED      145
  5671  SIGMA        REAL        ARRAY     C           REFS        13        35    DEFINED      144
  7011  SIGUB        REAL        ARRAY     C           REFS        13        35    DEFINED      146
   302  SSS          REAL                              REFS       134    DEFINED       56
  3731  STEP         REAL                  C           REFS        10    DEFINED      151
  4635  SUBNO        REAL        ARRAY     C           REFS         4        31    DEFINED       79
  7224  TLB          REAL        ARRAY     C           REFS        15        37    DEFINED      174
  7332  TNXST        REAL        ARRAY     C           REFS        15        37
   633  TPER         REAL                              REFS        72       126       134       183       190
                                                    DEFINED        68
   634  TPSGMA       REAL                              REFS        72       181       190     DEFINED       68
  7320  TPSIG        REAL        ARRAY     C           REFS        15        37    DEFINED      181
  7212  TSGMA        REAL        ARRAY     C           REFS        15        37    DEFINED      173
  7274  TSPER        REAL        ARRAY     C           REFS        15        37    DEFINED      180
  7236  TUB          REAL        ARRAY     C           REFS        15        37    DEFINED      175
  7306  TYPPER       REAL        ARRAY     C           REFS        15        37    DEFINED      182       183
  5054  VALUE        REAL        ARRAY     C           REFS         4        30    DEFINED       98
  4424  VLABLE       REAL        ARRAY     C           REFS         4        34    DEFINED      130
   644  VR           REAL        ARRAY                 REFS        31      4*72        87        88        98      2*129      135
                                                        144       145       145       173       174       175       180      185
                                                      4*190     DEFINED      4*68
    26  XLAMBD       REAL                  C           REFS        21    DEFINED      152
  3573  YMAX         REAL        ARRAY     C           REFS        27        25    DEFINED      128
  3612  YMIN         REAL        ARRAY     C           REFS        27        23    DEFINED      128

FILE NAMES          MODE
      TAPE5         MIXED                          READS        68       114       152
      TAPE6         MIXED                         WRITES        59        66        72        90       102       115       119      130
                                                    157        167       187       190

EXTERNALS              TYPE   ARGS          REFERENCES
      EOF              REAL     1               70
      EXIT                      0               62

NAMELISTS           DEF LINE      REFERENCES
      DAP              54          114       115

STATEMENT LABELS              DEF LINE    REFERENCES
   12  1                         68          80        84        88        94        99       105       108       112      116
                                            122       125       132       141       149       154       160       164      170
                                            184       186       193
  374  2       FMT               76          68
```

```
STATEMENT LABELS               DEF LINE   REFERENCES
   25  3                          81         77
   32  4                          85         81
   53  5                         100         85
   72  6                         113        100
    0  7             INACTIVE     77
  527  8       FMT               153        152
  472  9       FMT               127        126
   45  10                         95         89
  426  11      FMT               103        102
   62  12                        106        101
  454  13      FMT               120        119
  110  14                        123        118
  101  16                        117        113
  164  18                        150        133
  132  19                        133        117
    0  20                        130        129
  501  21      FMT               139        138
  151  22                        142        137
  366  30      FMT                75         72        190
  326  31      FMT                67         66
  256  50                        197         70
    0  55            INACTIVE     71         70
  172  100                       155        150
  560  104     FMT               168        167
  214  105                       171        166
  540  107     FMT               158        157
  201  108                       161        156
  407  103     FMT                91         90
  254  191                       194        155
  205  192                       165        135
  247  193                       167        136        165
  245  194                       185        134
    7  200                        64         58
  307  201     FMT                60         59
  576  5518    FMT               188        187

LOOPS  LABEL   INDEX    FROM-TO    LENGTH    PROPERTIES
  125  20      I        129 130      28       INSTACK

COMMON BLOCKS   LENGTH   MEMBERS - BIAS NAME(LENGTH)
      C          3830             0 C       (3830)

EQUIV CLASSES   LENGTH   MEMBERS - BIAS NAME(LENGTH)
C     C          3830             0 K       (3510)       18 PSIZE  (1)        20 IBVNSW (1)
                                 21 IPLOT   (1)          22 XLAMBD (1)        23 KSSIG  (1)
                                 24 CEPSIG  (6)        1980 ISCALE (15)     1915 YMAX   (15)
                               1930 YMIN    (15)       1983 NPLOT  (1)      1934 OUTPLT (15)
                               2007 PLOTNO  (1)        2008 NOPLOT (1)      2009 STEP   (1)
                               2324 VLABLE  (30)       2360 NOMOD  (1)      2351 MODNO  (99)
                               2460 NOSUB   (1)        2461 SUBNO  (99)     3019 IMVNDX (10)
                               3029 IMVGT   (1)        3065 NOLIST (1)      3056 LISTNO (50)
                               3116 VALUE   (50)       3166 NOOUT  (1)      3157 OUTNO  (50)
                               3217 ONAME1  (50)       3267 ONAME2 (50)     3317 ONAME3 (10)
                               3327 ONAME4  (10)       3358 COEFF  (28)     3386 REF    (28)
                               3414 BREF    (28)       3442 ATD    (5)      3447 BATD   (5)
                               3452 DTA     (4)        3456 BDTA   (4)      3510 RNSTRT (1)
                               3511 ISGGT   (1)        3513 SIGMA  (40)     3553 SIGLB  (40)
```

```
EQUIV CLASSES    LENGTH     MEMBERS - BIAS NAME(LENGTH)
                                 3993 SIGUB   (40)           3633 ISNOX   (43)          3573 IDIST   (40)
                                 3720 ITCT    (1)            3722 TSGMN   (10)          3732 TLB     (10)
                                 3742 TUB     (10)           3792 ITNOX   (10)          3752 ITDIST  (10)
                                 3772 TSPER   (10)           3782 TYPPER  (10)          3792 TPSIG   (10)
                                 3802 TNXST   (10)           3812 ITNOX2  (10)          3824 NCASE   (1)

STATISTICS
  PROGRAM LENGTH                6538      427
  CM LABELED COMMON LENGTH     73663     3830
```

```
      SUBROUTINE OUPT2                                                    IO    155
C     OUTPUT INITIALIZITION SUBROUTINE OUPT2                              IO    156
      COMMON /C/ C(3830)                                                  IO    157
      COMMON GRAPH                                                        IO    158
      EQUIVALENCE (C(2017),DTCNT ), (C(3167),NOOUT ), (C(2016),PGCNT ),   IO    159
C                 (C(2014),ITCNT ), (C(2003),PCNT  ), (C(2015),CPP   ),   IO    160
C                 (C(2018),TAPE  ), (C(2019),TAPENO), (C(2013),DOC   ),   IO    161
C                 (C(2000),T     ), (C(2021),KCONV ), (C(2025),TIME  ),   IO    162
C                 (C(2008),PLOTNO), (C(2009),NOPLOT), (C(3168),OUTNO ),   IO    163
C                 (C(2004),PPNT  ), (C(2023),OPOINT)                      IO    164
C     DIMENSION GRAPH(300,15),TIME(300),OUTNO(50)                         IO    165
      DIMENSION GRAPH(1,1),TIME(300),OUTNO(50)                            IO    166
      INTEGER     PGCNT , DTCNT , OUTNO , OPOINT                          IO    167
      EQUIVALENCE (C(1985),OUTPLT)                                        IO    168
      INTEGER OUTPLT                                                      IO    169
      DIMENSION OUTPLT(15)                                                IO    170
      KCONV=0                                                             IO    171
      ITCNT = DOC + 1.0                                                   IO    172
      PCNT = T-0.000001                                                   IO    173
      PGCNT = 1                                                           IO    174
      DTCNT = (NOOUT + 4)/5                                               IO    175
      IF ( ITCNT .GE. 7) GO TO 2                                          IO    176
      ITCNT = ITCNT + 1                                                   IO    177
      CALL DUMPO                                                          IO    178
C                                                                         IO    179
    2 CONTINUE                                                            IO    180
      OPOINT = 0   $ PPNT=C(2002)                                         IO    181
      DO 10 J=1,NOPLOT                                                    IO    182
      K=OUTPLT(J)                                                         IO    183
   10 GRAPH(1,J)=C(K)                                                     IO    184
      RETURN                                                              IO    185
      END                                                                 IO    186
```

```
 SUBROUTINE OUPT2      74/74   OPT=1                          FTN 4.2+74355      07/07/75  11.07.19.      PAGE    2

 SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS     DEF LINE    REFERENCES
   1  OUPT2           1          31

 VARIABLES     SN  TYPE              RELOCATION
     0  C          REAL       ARRAY    C           REFS      3     17*5      14        27        30
  3736  CPP        REAL                C           REFS      5     18
  3734  DOC        REAL                C           REFS      5     13      DEFINED     21
  3740  DTCNT      INTEGER             C           REFS      5     12      DEFINED     30
     0  GRAPH      REAL       ARRAY    / /         REFS      4     22        23      DEFINED     18        23
  3735  ITCNT      INTEGER             C           REFS      5     30      DEFINED     20
    33  J          INTEGER                         REFS     29   DEFINED     29
    34  K          INTEGER                         REFS     30   DEFINED     17
  3744  KCONV      INTEGER             C           REFS      5     21
  3136  NODUT      INTEGER             C           REFS      5     23
  3730  NOPLOT     INTEGER             C           REFS      5     13      DEFINED     27
  3746  OPOINT     INTEGER             C           REFS      5     12        13
  3157  OUTNO      INTEGER    ARRAY    C           REFS     14     15        16        29
  3700  OUTPLT     INTEGER    ARRAY    C           REFS      5   DEFINED     19
  3722  PCNT       REAL                C           REFS      5     13      DEFINED     28
  3737  PGCNT      INTEGER             C           REFS      5
  3727  PLOTNO     REAL                C           REFS      5   DEFINED     27
  3723  PPNT       REAL                C           REFS      5     19
  3717  T          REAL                C           REFS      5
  3741  TAPE       REAL                C           REFS      5
  3742  TAPEND     REAL                C           REFS      5
  3750  TIME       REAL       ARRAY    C           REFS      5     12

 EXTERNALS           TYPE   ARGS       REFERENCES
       DUMPO                  0            24

 STATEMENT LABELS              DEF LINE   REFERENCES
    20  2                          26          22
     0  10                         30          28

 LOOPS  LABEL    INDEX    FROM-TO     LENGTH     PROPERTIES
    25  10       J         28 30        39        INSTACK

 COMMON BLOCKS    LENGTH      MEMBERS - BIAS NAME(LENGTH)
      C            3830                  0 C        (3830)
      / /             1                  0 GRAPH    (1)

 EQUIV CLASSES    LENGTH      MEMBERS - BIAS NAME(LENGTH)
 C    C            3830             1984 OUTPLT (15)             1999 T       (1)             2032 PCNT    (1)
                                    2003 PPNT   (1)              2007 PLOTNO  (1)             2038 NOPLOT  (1)
                                    2012 DOC    (1)              2013 ITCNT   (1)             2014 CPP     (1)
                                    2015 PGCNT  (1)              2016 DTCNT   (1)             2017 TAPE    (1)
                                    2018 TAPEND (1)              2020 KCONV   (1)             2022 OPOINT  (1)
                                    2024 TIME   (300)            3166 NODUT   (1)             3157 OUTNO   (50)

 STATISTICS
   PROGRAM LENGTH                 35B       29
   CM LABELED COMMON LENGTH     7366B     3830
   CM BLANK COMMON LENGTH          1B        1
```

```
      SUBROUTINE OUPT3
C     OUTPUT SUBROUTINE OUPT3
      COMMON /C/ C(3830)
      COMMON GRAPH
      EQUIVALENCE (C(3168),OUTNO ), (C(3218),ONAME1), (C(3268),ONAME2),
C                 (C(2017),DTCNT ), (C(3167),NOOUT ), (C(2016),PGCNT ),
C                 (C(2014),ITCNT ), (C(2003),PCNT  ), (C(2015),CPP   ),
C                 (C(2000),T     ), (C(2664),DER   ), (C(2018),TAPE  ),
C                 (C(2019),TAPENO), (C(2008),PLOTNO), (C(2009),NOPLOT),
C                 (C(2005),PPP   ), (C(2004),PPNT  ), (C(2025),TIME  ),
C                 (C(2023),JPOINT)
      EQUIVALENCE (C(1985),OUTPLT)
      DIMENSION B(50),OUTNO(50),ONAME1(50),ONAME2(50)
C     DIMENSION GRAPH(300,15),TIME(300)
      DIMENSION TIME(300),GRAPH(1,1)
      DIMENSION OUTPLT(15)
      INTEGER DTCNT,PGCNT,OUTNO
      INTEGER OPOINT
      INTEGER OUTPLT
C
C** SAVE SPOT JITTER MAX/MIN VALUES
      IF(C(1680).GT.C(1567)) C(1557) = C(1680)
      IF(C(1680).LT.C(1560)) C(1558) = C(1680)
      IF(C(1681).GT.C(1577)) C(1577) = C(1681)
      IF(C(1681).LT.C(1578)) C(1578) = C(1681)
C
      IF (ITCNT. GT. 5) GO TO 7
      ITCNT = ITCNT + 1
      CALL DUMPO
      PGCNT = 1
C
    7 IF (DER. EQ. DER1) GO TO 8
      DER1 = DER
      WRITE(6,20)T,DER
   20 FORMAT(1H ,5HTIME=F14.7,2X,10HSTEP SIZE=1PE19.7)
    8 IF (T .LT. PCNT)GOTO15
    9 PCNT = PCNT + CPP
      IF (PGCNT. NE. 1) GO TO 3
      IF(NOOUT.LE.1) GO TO 3
    1 WRITE(6,2) (ONAME1(I),ONAME2(I), I=1,NOOUT)
    2 FORMAT (1H1,3X,4HTIME,5X,5(7X,2A6)//(20X,2A6,7X,2A6,7X,2A6,7X,
     12A6,7X,2A6)/)
      PGCNT = 2*DTCNT + 4
    3 IF(PGCNT .GE. 86) GO TO 1
      DO 4 I = 1,NOOUT
      J = OUTNO(I)
    4 B(I) = C(J)
      IF(NOOUT.LE.1) GO TO 15
      WRITE (6,5) T,(B(I), I = 1,NOOUT)
    5 FORMAT (///,F14.7,1P5E19.7/(14X,1P5E19.7))
      PGCNT = PGCNT + DTCNT + 4
   15 IF(T.LT.PPNT.OR.NOPLOT.EQ.0)RETURN
      PPNT=PPNT+PPP
      KPOINT =JPOINT +1
      IF (KPOINT-300) 16,13,13
   13 WRITE (6,14)
   14 FORMAT (//71H ****  WARNING-PLOTTING ARRAY FILLED-ONLY FIRST 300 P
```

```
      POINTS PLOTTED ****,//)                                   IO      244
   16 UPOINT=KPOINT                                             IO      245
      TIME (UPOINT)=T                                           IO      246
      DO 10 J=1,NOPLOT                                          IO      247
      K=OUTPLT(J)                                               IO      248
   10 GRAPH(UPOINT   ,J)=C(K)                                   IO      249
   18 RETURN                                                    IO      250
      END                                                       IO      251
```

```
SUBROUTINE OUPT3      74/74    OPT=1                               FTN 4.2+74335      07/07/76  11.07.21.      PAGE     3

           SYMBOLIC REFERENCE MAP (R=3)

  ENTRY POINTS       DEF LINE      REFERENCES
      1  OUPT3            1            52          54

  VARIABLES      SN  TYPE                RELOCATION
    207  B            REAL          ARRAY                   REFS        13        43    DEFINED       47
      0  C            REAL          ARRAY     C             REFS         3      19*5       12       3*22      3*23      3*24      3*25
                                                            47          63   DEFINED       22         23        24        25
   3736  CPP          REAL                    C             REFS         5        37
   3147  DER          REAL                    C             REFS         5        32       33         34
    202  DER1         REAL                                  REFS        32   DEFINED       33
   3740  DTCNT        INTEGER                 C             REFS         5        12       43         51
      0  GRAPH        REAL          ARRAY     / /           REFS         4        15    DEFINED       63
    203  I            INTEGER                               REFS      2*40        45       47         49    DEFINED        40        45
                                                            49
   3735  ITCNT        INTEGER                 C             REFS         5        27       28    DEFINED        28
    204  J            INTEGER                               REFS        47        62       63    DEFINED        46        61
    206  K            INTEGER                               REFS        63   DEFINED       62
    205  KPOINT       INTEGER                               REFS        55        53    DEFINED       54
   3136  NODUT        INTEGER                 C             REFS         5        34       40         45        48        49
   3730  NOPLOT       INTEGER                 C             REFS         5        52       61
   3221  ONAME1       REAL          ARRAY     C             REFS         5        13       40
   3303  ONAME2       REAL          ARRAY     C             REFS         5        13       40
   3746  OPOINT       INTEGER                 C             REFS         5        13       54         60        63
                                                       DEFINED          59
   3137  OUTNO        INTEGER       ARRAY     C             REFS         5        13       17         46
   3700  OUTPLT       INTEGER       ARRAY     C             REFS        12        15       19         62
   3722  PCNT         REAL                    C             REFS         5        35       37    DEFINED        37
   3737  PGCNT        INTEGER                 C             REFS         5        17       38         44        51
                                                       DEFINED          30        43       51
   3727  PLOTNO       REAL                    C             REFS         5
   3723  PPNT         REAL                    C             REFS         5        52       53    DEFINED        53
   3724  PPP          REAL                    C             REFS         5        53
   3717  T            REAL                    C             REFS         5        34       36         49        52        60
   3741  TAPE         REAL                    C             REFS         5
   3742  TAPEND       REAL                    C             REFS         5
   3750  TIME         REAL          ARRAY     C             REFS         5        15    DEFINED       60

  FILE NAMES         MODE
         TAPE6        FMT                      WRITES        34        40        43       56

  EXTERNALS               TYPE   ARGS        REFERENCES
         DUMPO                     0            29

  STATEMENT LABELS                DEF LINE    REFERENCES
     36   1                          40          44
    145   2         FMT              41          40
     54   3                          44          38        39
      0   4                          47          45
    161   5         FMT              50          49
     23   7                          32          27
     27   8                          36          32
      0   9            INACTIVE      37
      0  10                          63          61
      0  13            INACTIVE      56          55
    171  14         FMT              57          56
```

```
SUBROUTINE QUF13        74/74   OPT=1                            FTN 4.2+74355       07/07/75  11.07.21.      PAGE    4

STATEMENT LABELS                    DEF LINE    REFERENCES
   77  15                               52          36          48
  112  16                               59          55
  123  18                               64          55
  131  20         FMT                   35          34

LOOPS  LABEL     INDEX       FROM-TO       LENGTH     PROPERTIES
   41             I          40             109                     EXT REFS
   61  4          I          45  47         33         INSTACK
  120  10         J          61  63         33         INSTACK

COMMON BLOCKS    LENGTH       MEMBERS - BIAS NAME(LENGTH)
      C           3830                  0 C        (3830)
      //             1                  0 GRAPH    (1)

EQUIV CLASSES    LENGTH       MEMBERS - BIAS NAME(LENGTH)
C     C           3830             1984 OUTPLT (15)          1999 T       (1)          2012 PCNT    (1)
                                   2003 PPNT   (1)           2004 PPP     (1)          2037 PLOTNO  (1)
                                   2003 NOPLOT (1)           2013 ITCNT   (1)          2014 CPP     (1)
                                   2015 PSCNT  (1)           2016 DTCNT   (1)          2017 TAPE    (1)
                                   2018 TAPENO (1)           2022 OPOINT  (1)          2024 TIME    (300)
                                   2663 DER    (1)           3166 NOOUT   (1)          3157 OUTNO   (58)
                                   3217 ONAME1 (50)          3267 ONAME2  (50)

STATISTICS
   PROGRAM LENGTH                  2713B     185
   CM LABELED COMMON LENGTH        7366B     3830
   CM BLANK COMMON LENGTH          1B        1
```

```
      SUBROUTINE ZERO                                      IO      252
      COMMON /C/ C(3830)                                   IO      253
      EQUIVALENCE (C(1984),NPLOT )                         IO      254
      EQUIVALENCE (C(2023),OPOINT)                         IO      255
      EQUIVALENCE (C(2361),NOMOD )                         IO      256
      EQUIVALENCE (C(2461),NOSUB )                         IO      257
      EQUIVALENCE (C(3066),NOLIST)                         IO      258
      EQUIVALENCE (C(3167),NOOUT )                         IO      259
      INTEGER OPOINT                                       IO      260
      NOSUB = 0                                            IO      261
      NOMOD = 0                                            IO      262
      NOOUT = 0                                            IO      263
      NOLIST = 0                                           IO      264
      OPOINT=0                                             IO      265
      NPLOT=0                                              IO      266
      RETURN                                               IO      267
      END                                                  IO      268
```

```
         SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS     DEF LINE      REFERENCES
   1  ZERO           1           16

VARIABLES       SN  TYPE             RELOCATION
    0 C              REAL      ARRAY     C          REFS      2        3         4       5       6       7       8
 3771  NOLIST        INTEGER             C          REFS      7    DEFINED      13
 4470  NOMOD         INTEGER             C          REFS      5    DEFINED      11
 3136  NODUT         INTEGER             C          REFS      8    DEFINED      12
 4634  NOSUB         INTEGER             C          REFS      6    DEFINED      10
 3677  NPLOT         INTEGER             C          REFS      3    DEFINED      15
 3746  OPOINT        INTEGER             C          REFS      4        9    DEFINED      14

COMMON BLOCKS    LENGTH      MEMBERS - BIAS NAME(LENGTH)
      C           3830              0 C      (3830)

EQUIV CLASSES    LENGTH      MEMBERS - BIAS NAME(LENGTH)
 C     C          3830          1903 NPLOT   (1)              2022 OPOINT (1)              2359 NOMOD   (1)
                                2460 NOSUB   (1)              3065 NOLIST (1)              3156 NODUT   (1)

STATISTICS
  PROGRAM LENGTH                  6B     6
  CM LABELED COMMON LENGTH     73660   3830
```

```
      SUBROUTINE PLOT4(ISCALE,XMAX,XMIN,YMAX,YMIN,XSAVE,YSAVE,NTOP,HLAB,
     . VLAB,II,ITIME)
C
C DELETE THIS CARD WHEN MAKING PLOT RUNS
      DIMENSION X(1),Y(1)
C
      DIMENSION XSAVE(1),YSAVE(1),X(300),Y(300),LAB(2),LBL(2),VLAB(2),
     + HLAB(2)
      DATA IM,KK,ALEN,ALEN2,NC,NC2/0,0,10.,5.,-12,12/
      ENCODE(12,99,LBL)VLAB(1),VLAB(2)
      ENCODE(12,99,LAB)HLAB(1),HLAB(2)
   99 FORMAT(2A6)
      IIK=II+1
      NST=2          $     NSTOP=NTOP-3 $       IKK=1
      IF(ISCALE.EQ.0)YMAX=1.E10
      IF(ISCALE.EQ.0)YMIN=-1.E10
      DO 50 I=NST,NSTOP
      X(IKK)=XSAVE(I)          $         Y(IKK)=YSAVE(I)
      IKK=IKK+1
   50 CONTINUE
      NTOP=IKK-1
      IF(KK.EQ.0)CALL INITAL(1,100,22,0,0,0)
      KK=1
      II=II+1
      IF(II.NE.1)GO TO 60
      CALL RSTR(3)
      CALL PLOT(-1.5,-1.,0)
      GO TO 61
   60 CONTINUE
      CALL PLOT(-1.5,ALEN2,3)
      CALL PLOT(-1.5,-1.,0)
   61 CONTINUE
      IF(II.EQ.3)II=0
      IF(ISCALE.EQ.0)GO TO 40
      DY=(YMAX-YMIN)/ALEN2
      DO 10 I=1,NTOP
   10 Y(I)=(AMAX1(YMIN,AMIN1(YMAX,Y(I)))-YMIN)/DY
      CALL PLOT(0.0,0.0,3)
      CALL PLOT(0.,ALEN2,2)
      YY=0.
      YFLT=YMIN
      NTICY=ALEN2+1
      DO 20 I=1,NTICY
      CALL NUMBER(-.2,YY,-.14,YFLT,0.0,2)
      CALL PLOT(-.1,YY,3)
      CALL PLOT(0.0,YY,2)
      YY=YY+1
      YFLT=YFLT+DY
   20 CONTINUE
      CALL SYMBOL(-1.0 ,ALEN2/2.-.5,.14,LBL,90.,12)
      IF(ISCALE.EQ.1 .OR. ITIME.EQ.0)GO TO 41
      DX=(XMAX-XMIN)/ALEN
      DO 100 I=1,NTOP
  100 X(I)=(AMAX1(XMIN,AMIN1(XMAX,X(I)))-XMIN)/DX
      CALL PLOT(0.,0.,3)
      CALL PLOT(ALEN,0.,2)
      XX=0.   $  XFLT=XMIN    $    NTICX=ALEN+1
```

```
      DO 200 I=1,NTICX
      CALL NUMBER(XX,-.4,+.14,XFLT,0.,2)
      CALL PLOT(XX,-.1,3)
      CALL PLOT(XX,0,2)
      XX=XX+1 $ XFLT=XFLT+DX
  200 CONTINUE
      CALL SYMBOL(ALEN/2.-.5,-.75,.14,LAB,0.,12)
      GO TO 42
   40 CONTINUE
      CALL SCALE(Y,NTOP,ALEN2,YMIN,DY)
      CALL AXIS(0.,0.,LBL,NC2,ALEN2,90.,YMIN,DY,2)
   41 CONTINUE
      CALL SCALE(X,NTOP,ALEN,XMIN,DX)
      CALL AXIS(0.0,0.0,LAB,NC,ALEN,0.0,XMIN,DX,2)
   42 CONTINUE
      CALL LINE(X,Y,NTOP,0,1)
      CALL PLOT(0.0,0.0,3)
      NTOP=NSTOP+3
      RETURN
      END
```

CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
7	I	X	PREVIOUSLY DIMENSIONED ARRAY. FIRST DIMENSIONS WILL BE RETAINED.
7	I	Y	PREVIOUSLY DIMENSIONED ARRAY. FIRST DIMENSIONS WILL BE RETAINED.

```
     SUBROUTINE PLOT4       74/74    OPT=1                              FTN 4.2+74355        07/07/75  11.07.28.       PAGE      4

          SYMBOLIC REFERENCE MAP (R=3)

  ENTRY POINTS        DEF LINE       REFERENCES
     3  PLOT4               1          70

  VARIABLES         SN  TYPE              RELOCATION
    417  ALIN           REAL                                   REFS         52         55         57         64         70         71
                                                            DEFINED          9
    420  ALIN2          REAL                                   REFS         30         35         39         42         58         67         68
                                                            DEFINED          9
    503  DX             REAL                                   REFS         54         62         70         71    DEFINED         52
    477  DY             REAL                                   REFS         37         43         67         68    DEFINED         35
      0  HLAB           REAL          ARRAY        F.P.        REFS          7       2*11    DEFINED          1
    476  I              INTEGER                                REFS       2*18       2*37       2*54    DEFINED         17         36         43
                                                                 53         58
      0  II             INTEGER                    F.P.        REFS         13         24         25         33    DEFINED          1         24
                                                                 33
    472  IIK          * INTEGER                             DEFINED         13
    475  IKK            INTEGER                                REFS       2*13         13         21    DEFINED         14         19
    415  IM           * INTEGER                             DEFINED          9
      0  ISCALE         INTEGER                    F.P.        REFS         15         16         34         51    DEFINED          1
      0  ITIME          INTEGER                    F.P.        REFS         51    DEFINED          1
    416  KK             INTEGER                                REFS         22    DEFINED          9         23
    511  LAB            INTEGER       ARRAY                    REFS          7         64         71    DEFINED         11
    513  LBL            INTEGER       ARRAY                    REFS          7         50         68    DEFINED         10
    421  NC             INTEGER                                REFS         71    DEFINED          9
    422  NC2            INTEGER                                REFS         68    DEFINED          9
    473  NST            INTEGER                                REFS         17    DEFINED         14
    474  NSTOP          INTEGER                                REFS         17         75    DEFINED         14
    506  NTICX          INTEGER                                REFS         58    DEFINED         57
    502  NTICY          INTEGER                                REFS         43    DEFINED         42
      0  NTOP           INTEGER                    F.P.        REFS         14         35         53         67         70         73
                                                            DEFINED          1         21         75
      0  VLAB           REAL          ARRAY        F.P.        REFS          7       2*10    DEFINED          1
    507  X              REAL          ARRAY                    REFS          5          7         54         70         73
                                                            DEFINED         18         54
    505  XFLT           REAL                                   REFS         59         62    DEFINED         57         62
      0  XMAX           REAL                       F.P.        REFS         52         54    DEFINED          1
      0  XMIN           REAL                       F.P.        REFS         52       2*54         57         70         71
                                                            DEFINED          1
      0  XSAVE          REAL          ARRAY        F.P.        REFS          7         13    DEFINED          1
    504  XX             REAL                                   REFS         59         60         61         62    DEFINED         57         62
    510  Y              REAL          ARRAY                    REFS          5          7         37         67         73
                                                            DEFINED         18         37
    501  YFLT           REAL                                   REFS         44         43    DEFINED         41         46
      0  YMAX           REAL                       F.P.        REFS         35         37    DEFINED          1         15
      0  YMIN           REAL                       F.P.        REFS         35       2*37         41         67         68
                                                            DEFINED          1         15
      0  YSAVE          REAL          ARRAY        F.P.        REFS          7         13    DEFINED          1
    500  YY             REAL                                   REFS         44         45         46         47    DEFINED         40         47

  EXTERNALS              TYPE    ARGS         REFERENCES
         AXIS                       9             58         71
         INITAL                     6             22
         LINE                       5             73
         NUMBER                     6             44         59
         PLOT                       3             27         30         31         33         39         45         46         55         56
```

```
      SUBROUTINE PLOT4       74/74    OPT=1                           FTN 4.2+74353       07/07/75  11.07.25.       PAGE     5

EXTERNALS          TYPE   ARGS        REFERENCES
                                         50          61          74
      RSTR                  1            26
      SCALE                 5            57          70
      SYMBOL                6            50          64

INLINE FUNCTIONS    TYPE   ARGS          DEF LINE  REFERENCES
      AMAXI      REAL       0  INTRIN                    37          54
      AMIN1      REAL       0  INTRIN                    37          54

STATEMENT LABELS                  DEF LINE   REFERENCES
     0  10                           37        36
     0  20                           49        43
   211  40                           66        34
   220  41                           69        51
   227  42                           72        65
     0  50                           20        17
    53  60                           29        25
    57  61                           32        28
   437  99          FMT              12        10           11
     0  100                          54        53
     0  200                          63        58

LOOPS  LABEL    INDEX       FROM-TO    LENGTH    PROPERTIES
   32  50        I           17 20        48      INSTACK
   73  10        I           36 37        60      INSTACK
  112  20      * I           43 49       159                 EXT REFS
  150  100       I           53 54        68      INSTACK
  167  200     * I           58 63       158                 EXT REFS

STATISTICS
  PROGRAM LENGTH                 5159     333
```

```
      SUBROUTINE   SUBL1                                          EXEC    2
      COMMON /C/ C(3830)                                          EXEC    3
      EQUIVALENCE (C(2461),NOSUB ), (C(2462),SUBNO )              EXEC    4
      DIMENSION   SUBNO(99)                                       EXEC    5
      DO 1 I = 1, NOSUB                                           EXEC    6
      J = SUBNO(I)                                                EXEC    7
      GO TO ( 1, 2, 3, 4, 5, 6, 7, 8, 9 ), J                      EXEC    8
    2 CALL INPT1                                                  EXEC    9
      GO TO 1                                                     EXEC   10
    3 CALL OUPT1                                                  EXEC   11
      GO TO 1                                                     EXEC   12
    4 CALL STGE1                                                  EXEC   13
      GO TO 1                                                     EXEC   14
    5 CALL CNTR1                                                  EXEC   15
      GO TO 1                                                     EXEC   16
    6 CALL RND41                                                  EXEC   17
      GO TO 1                                                     EXEC   18
    7 CALL AUXA1                                                  EXEC   19
      GO TO 1                                                     EXEC   20
    8 CALL AUXB1                                                  EXEC   21
      GO TO 1                                                     EXEC   22
    9 CALL AUXC1                                                  EXEC   23
    1 CONTINUE                                                    EXEC   24
      RETURN                                                      EXEC   25
      END                                                         EXEC   26
```

```
SUBROUTINE SUBL1      74/74    OPT=1                        FTN 4.2+74355      07/07/75  11.07.30.      PAGE    2

        SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE      REFERENCES
    1  SUBL1           1          24

VARIABLES      SN  TYPE           RELOCATION
     0  C          REAL        ARRAY   C             REFS        2      2*3
    44  I          INTEGER                           REFS        6   DEFINED        5
    45  J          INTEGER                           REFS        7   DEFINED        6
  +634  NOSUB      INTEGER                 C         REFS        3       5
  +635  SUBNO      REAL        ARRAY       C         REFS        3       *          6

EXTERNALS               TYPE   ARGS       REFERENCES
        AUXA1                   0           18
        AUXB1                   0           20
        AUXC1                   0           22
        CNTR1                   0           14
        INPT1                   0            8
        OUPT1                   0           10
        RNDM1                   0           16
        STGE1                   0           12

STATEMENT LABELS             DEF LINE   REFERENCES
    41  1                       23         5       7       9      11      13      15      17      19      21
    22  2                        8         7
    24  3                       10         7
    26  4                       12         7
    30  5                       14         7
    32  6                       16         7
    34  7                       18         7
    36  8                       20         7
    40  9                       22         7

LOOPS  LABEL     INDEX     FROM-TO    LENGTH     PROPERTIES
    3  1       * I          5 23       41B                   EXT REFS

COMMON BLOCKS    LENGTH     MEMBERS - BIAS NAME(LENGTH)
        C         3830                 0 C      (3830)

EQUIV CLASSES    LENGTH     MEMBERS - BIAS NAME(LENGTH)
C       C         3830           2460 NOSUB  (1)           2461 SUBNO  (99)

STATISTICS
  PROGRAM LENGTH                 46B       38
  CM LABELED COMMON LENGTH     7366B     3830
```

```
      SUBROUTINE   SUBL2                                          EXEC    27
                                                                  EXEC    28
      COMMON /C/ C(3838)                                          EXEC    29
      EQUIVALENCE (C(2461),NOSUB ),  (C(2462),SUBNO )             EXEC    30
      DIMENSION   SUBNO(99)                                       EXEC    31
      DO 1 I = 1, NOSUB                                           EXEC    32
      J = SUBNO(I)                                                EXEC    33
      GO TO ( 1, 2, 3, 4, 5, 6, 7, 8, 9 ), J                      EXEC    34
    2 CALL INPT2                                                  EXEC    35
      GO TO 1                                                     EXEC    36
    3 CALL OUPT2                                                  EXEC    37
      GO TO 1                                                     EXEC    38
    4 CALL STOE2                                                  EXEC    39
      GO TO 1                                                     EXEC    40
    5 CALL CNTR2                                                  EXEC    41
      GO TO 1                                                     EXEC    42
    6 CALL RNDM2                                                  EXEC    43
      GO TO 1                                                     EXEC    44
    7 CALL AUXA2                                                  EXEC    45
      GO TO 1                                                     EXEC    46
    8 CALL AUXB2                                                  EXEC    47
      GO TO 1                                                     EXEC    48
    9 CALL AUXC2                                                  EXEC    49
    1 CONTINUE                                                    EXEC    50
      RETURN                                                      EXEC    51
      END                                                         EXEC    52
```

```
      SUBROUTINE SUBL2       74/74    OPT=1                           FTN 4.2+74355      07/07/75  11.07.31.        PAGE     2

      SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE      REFERENCES
   1  SUBL2           1             25

VARIABLES       SN  TYPE              RELOCATION
     0  C           REAL         ARRAY    C                 REFS        3       2*4
    44  I           INTEGER                                 REFS        7     DEFINED         6
    45  J           INTEGER                                 REFS        8     DEFINED         7
  +634  NOSUB       INTEGER                 C               REFS        4        6
  +635  SUBNO       REAL         ARRAY    C                 REFS        4        5            7

EXTERNALS             TYPE    ARGS          REFERENCES
        AUXA2                  0                 19
        AUXB2                  0                 21
        AUXC2                  0                 23
        CNTR2                  0                 15
        INPT2                  0                  9
        OUPT2                  0                 11
        RNDM2                  0                 17
        STSE2                  0                 13

STATEMENT LABELS                 DEF LINE    REFERENCES
    41  1                           24           6         8         10        12        14        16        18        20        22
    22  2                            9           8
    24  3                           11           8
    26  4                           13           8
    30  5                           15           8
    32  6                           17           8
    34  7                           19           8
    36  8                           21           8
    40  9                           23           8

LOOPS  LABEL    INDEX      FROM-TO     LENGTH     PROPERTIES
   3   1       * I          6 24        41B                  EXT REFS

COMMON BLOCKS    LENGTH      MEMBERS - BIAS NAME(LENGTH)
       C          3830              0 C        (3830)

EQUIV CLASSES    LENGTH      MEMBERS - BIAS NAME(LENGTH)
C      C          3830           2460 NOSUB  (1)              2461 SUBNO  (99)

STATISTICS
  PROGRAM LENGTH                  46B       38
  CM LABELED COMMON LENGTH      7366B     3830
```

```
      SUBROUTINE   SUBL3                                                 EXEC      53
      COMMON /C/ C(3830)                                                 EXEC      54
      EQUIVALENCE (C(2461),NOSUB ), (C(2462),SUBNO )                     EXEC      55
      DIMENSION   SUBNO(99)                                              EXEC      56
      DO 1 I = 1, NOSUB                                                  EXEC      57
      J = SUBNO(I)                                                       EXEC      58
      GO TO ( 1, 2, 3, 4, 5, 6, 7, 8, 9 ), J                             EXEC      59
    2 CALL INPT3                                                         EXEC      60
      GO TO 1                                                            EXEC      61
    3 CALL OUPT3                                                         EXEC      62
      GO TO 1                                                            EXEC      63
    4 CALL STGE3                                                         EXEC      64
      GO TO 1                                                            EXEC      65
    5 CALL CNTR3                                                         EXEC      66
      GO TO 1                                                            EXEC      67
    6 CALL RNDM3                                                         EXEC      68
      GO TO 1                                                            EXEC      69
    7 CALL AUXA3                                                         EXEC      70
      GO TO 1                                                            EXEC      71
    8 CALL AUXB3                                                         EXEC      72
      GO TO 1                                                            EXEC      73
    9 CALL AUXC3                                                         EXEC      74
    1 CONTINUE                                                           EXEC      75
      RETURN                                                             EXEC      76
      END                                                                EXEC      77
```

```
      SUBROUTINE SUBL3      74/74    OPT=1                                 FTN 4.2+74.353       07/07/75  11.07.32.       PAGE     2

         SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS      DEF LINE      REFERENCES
     1  SUBL3           1          24

 VARIABLES       SN  TYPE              RELOCATION
      0  C            REAL        ARRAY     C            REFS        2        2*3
     44  I            INTEGER                            REFS        6    DEFINED        5
     45  J            INTEGER                            REFS        7    DEFINED        6
   4634  NOSUB        INTEGER                C           REFS        3          5
   4635  SUBNO        REAL        ARRAY     C            REFS        3          4        6

 EXTERNALS             TYPE    ARGS        REFERENCES
          AUXA3                  0             18
          AUXB3                  0             20
          AUXC3                  0             22
          CNTR3                  0             14
          INPT3                  0              8
          OUPT3                  0             10
          RNDM3                  0             16
          STSE3                  0             12

 STATEMENT LABELS               DEF LINE   REFERENCES
     41  1                          23          5        7        9       11       13       15       17       19       21
     22  2                           8          7
     24  3                          10          7
     26  4                          12          7
     30  5                          14          7
     32  6                          16          7
     34  7                          18          7
     36  8                          20          7
     40  9                          22          7

 LOOPS   LABEL     INDEX      FROM-TO     LENGTH      PROPERTIES
     3   1       * I            5 23        41B                EXT REFS

 COMMON BLOCKS   LENGTH      MEMBERS - BIAS NAME(LENGTH)
          C        3830               0 C      (3830)

 EQUIV CLASSES   LENGTH      MEMBERS - BIAS NAME(LENGTH)
 C        C        3830            2460 NOSUB  (1)            2461 SUBNO  (99)

 STATISTICS
   PROGRAM LENGTH                     46B       38
   CM LABELED COMMON LENGTH         7366B     3830
```

```
      SUBROUTINE STGE2                                                  EXEC   78
      COMMON /C/ C(3830)                                                EXEC   79
      EQUIVALENCE (C(2011),KSTEP ), (C(2020),LCONV ), (C(2021),KCONV )  EXEC   80
      KCONV = 0                                                         EXEC   81
      LCONV = 0                                                         EXEC   82
      KSTEP = 1.                                                        EXEC   83
      RETURN                                                            EXEC   84
      END                                                               EXEC   85
```

```
       SUBROUTINE STGE2       74/74    OPT=1                        FTN 4.2+74355       07/07/75  11.07.33.       PAGE      2

       SYMBOLIC REFERENCE MAP (R=3)

  ENTRY POINTS      DEF LINE      REFERENCES
     1  STGE2            1             7

  VARIABLES       SN  TYPE            RELOCATION
      0  C             REAL          ARRAY    C               REFS           2        8*3
   3744  KCONV         INTEGER                C               REFS           3     DEFINED          4
   3732  KSTEP         INTEGER                C               REFS           3     DEFINED          6
   3743  LCONV         INTEGER                C               REFS           3     DEFINED          5

  COMMON BLOCKS     LENGTH      MEMBERS - BIAS NAME(LENGTH)
          C           3830                0 C       (3830)

  EQUIV CLASSES     LENGTH      MEMBERS - BIAS NAME(LENGTH)
C         C           3830           2010 KSTEP  (1)                2019 LCONV  (1)                2020 KCONV  (1)

  STATISTICS
    PROGRAM LENGTH                      5B       5
    CM LABELED COMMON LENGTH         7366B    3830
```

```
SUBROUTINE STGE3       74/74    OPT=1                       FTN 4.2+74355       07/07/75   11.07.33.       PAGE      1

                  SUBROUTINE STGE3                                                   EXEC      86
                  COMMON /C/ C(3830)                                                 EXEC      87
                  EQUIVALENCE (C(2000),T      ), (C(2001),TF     ), (C(2003),PCNT  ) EXEC      88
                  EQUIVALENCE (C(2010),STEP   ), (C(2011),KSTEP  ), (C(2020),LCONV ) EXEC      89
                  EQUIVALENCE (C(2021),KCONV  ), (C(2561),N      ), (C(2662),HMIN  ) EXEC      90
                  EQUIVALENCE (C(2663),HMAX   ), (C(2664),DER    ), (C(2765),EL    ) EXEC      91
                  EQUIVALENCE (C(2865),EU     ), (C(2965),VAR    )                   EXEC      92
                  EQUIVALENCE (C(1973),KASE   ), (C(1974),NJ     ), (C(1975),NPT   ) EXEC      93
                  DIMENSION    DER(101)          , VAR(101)         , EL(100)        EXEC      94
                  EXTERNAL AUXSUB                                                    EXEC      95
                  CALL G4                                                            EXEC      96
                  IF (ABS( T-TF) .LE. 0.01 ) GO TO 20                                EXEC      97
                  IF ( (TF-T) .LT. 0.) GO TO 10                                      EXEC      98
                  IF (LCONV .EQ. 2) GO TO 20                                         EXEC      99
                  IF (LCONV .EQ. 1) GO TO 10                                         EXEC     100
                  IF(DER(1) .LT. 0.) DER(1)=-DER(1)*.5                               EXEC     101
                  RETURN                                                             EXEC     102
               10 IF(DER(1) .GT. 0.) DER(1)=-DER(1)*.5                               EXEC     103
                  KCONV = KCONV + 1                                                  EXEC     104
                  IF(KCONV .GE. 10) GO TO 20                                         EXEC     105
                  RETURN                                                             EXEC     106
               20 PCNT = 1.0                                                         EXEC     107
                  IF(STEP .EQ.11.)GOTO 40                                            EXEC     108
                  PREDER = DER(1)                                                    EXEC     109
                  DER(1) = 0.                                                        EXEC     110
                  NJ=N-1                                                             EXEC     111
                  NPT=0                                                              EXEC     112
                  CALL AMRK(AUXSUB)                                                  EXEC     113
                  DER(1) = PREDER                                                    EXEC     114
               40 CALL OUPT3                                                         EXEC     115
                  KSTEP = 2                                                          EXEC     116
                  RETURN                                                             EXEC     117
                  END                                                                EXEC     118
```

```
       SUBROUTINE STGE3        74/74    OPT=1                        FTN 4.2+74355        07/07/75  11.07.33.      PAGE    2

       SYMBOLIC REFERENCE MAP (R=3)

   ENTRY POINTS      DEF LINE      REFERENCES
     1  STGE3            1           17          21          32

 . VARIABLES      SN  TYPE            RELOCATION
       0  C           REAL        ARRAY   C              REFS          2        3*3         3*4        3*5        8*6        2*7        3*8
    3147  DER         REAL        ARRAY . C              REFS          6          9        2*16       2*18        24
                                                      DEFINED         16         18          25         29
    3314  EL          REAL        ARRAY   C              REFS          6          9
    3460  EU          REAL                C              REFS          7
    3146  HMAX        REAL                C              REFS          6
    3145  HMIN        REAL                C              REFS          5
    3664  KASE        INTEGER             C              REFS          8
    3744  KCONV       INTEGER             C              REFS          5         19          20     DEFINED         19
    3732  KSTEP       INTEGER             C              REFS          4    DEFINED          31
    3743  LCONV       INTEGER             C              REFS          4         14          15
    3000  N           INTEGER             C              REFS          5         25
    3665  NJ          INTEGER             C              REFS          8    DEFINED          26
    3666  NPT         INTEGER             C              REFS          8    DEFINED          27
    3722  PCNT        REAL                C              REFS          3    DEFINED          22
      52  PREDER      REAL                               REFS         29    DEFINED          24
    3731  STEP        REAL                C              REFS          4         23
    3717  T           REAL                C              REFS          3         12          13
    3720  TF          REAL                C              REFS          3         12          13
    3624  VAR         REAL        ARRAY   C              REFS          7          9

   EXTERNALS          TYPE    ARGS        REFERENCES
          AMRK                  1             28
          AUXSUB                0             10          28
          G4                    0             11
          CUPT3                 0             30

   INLINE FUNCTIONS   TYPE    ARGS         DEF LINE   REFERENCES
          ABS         REAL      1   INTRIN               12

   STATEMENT LABELS             DEF LINE    REFERENCES
     20  10                        18          13          15
     26  20                        22          12          14          20
     41  40                        30          23

   COMMON BLOCKS     LENGTH      MEMBERS - BIAS NAME(LENGTH)
          C           3830               0  C      (3830)

   EQUIV CLASSES     LENGTH      MEMBERS - BIAS NAME(LENGTH)
 C        C           3830          1972 KASE      (1)           1973 NJ        (1)             1974 NPT     (1)
                                    1999 T         (1)           2000 TF        (1)             2012 PCNT    (1)
                                    2009 STEP      (1)           2010 KSTEP     (1)             2019 LCONV   (1)
                                    2020 KCONV     (1)           2560 N         (1)             2551 HMIN    (1)
                                    2662 HMAX      (1)           2663 DER       (101)           2754 EL      (100)
                                    2864 EU        (1)           2964 VAR       (101)

   STATISTICS
     PROGRAM LENGTH                 53B        43
     CM LABELED COMMON LENGTH     7366B      3830
```

```
      SUBROUTINE RESET                                                    EXEC   119
      COMMON /C/ C(3830)                                                  EXEC   120
      EQUIVALENCE (C(3066),NOLIST), (C(3067),LISTNO), (C(3117),VALUE )    EXEC   121
      DIMENSION   LISTNO(50)      , VALUE(50)                             EXEC   122
      IF (NOLIST .EQ. 0) RETURN                                           EXEC   123
      DO 1 I = 1, NOLIST                                                  EXEC   124
      J = LISTNO(I)                                                       EXEC   125
    1 C(J) = VALUE(I)                                                     EXEC   126
      RETURN                                                              EXEC   127
      END                                                                 EXEC   128
```

```
      SUBROUTINE RESET      74/74    OPT=1                        FTN 4.2+74355      07/07/75  11.07.34.       PAGE     2

CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM

     8      I      NOLIST    THIS STATEMENT MAY REDEFINE A CURRENT LOOP CONTROL VARIABLE OR PARAMETER.
```

```
       SUBROUTINE RESET       74/74   OPT=1                          FTN 4.2+74355      07/07/75  11.07.34.      PAGE     3

       SYMBOLIC REFERENCE MAP (R=3)

  ENTRY POINTS        DEF LINE     REFERENCES
     1  RESET               1           5         9

  VARIABLES       SN  TYPE               RELOCATION
      0  C            REAL         ARRAY    C                 REFS          2          3*3    DEFINED          8
     11  I            INTEGER                                 REFS          7            8    DEFINED          6
     12  J            INTEGER                                 REFS          8    DEFINED              7
   3772  LISTNO       INTEGER      ARRAY    C                 REFS          3            4            7
   3771  NOLIST       INTEGER               C                 REFS          3            5            6
   3054  VALUE        REAL         ARRAY    C                 REFS          3            4            8

  STATEMENT LABELS                         DEF LINE    REFERENCES
      0  1                                     8           6

  LOOPS   LABEL      INDEX       FROM-TO       LENGTH     PROPERTIES
      6   1          I             6  8          3B         INSTACK

  COMMON BLOCKS    LENGTH        MEMBERS - BIAS NAME(LENGTH)
            C        3830                   0 C      (3830)

  EQUIV CLASSES    LENGTH        MEMBERS - BIAS NAME(LENGTH)
C           C        3830              3065 NOLIST (1)                3066 LISTNO (50)                3116 VALUE  (50)

  STATISTICS
    PROGRAM LENGTH                     13B        11
    CM LABELED COMMON LENGTH         7366B      3830
```

```
      SUBROUTINE TABLE (X,XI,YI,NX,XK,XLABEL,Y)                EXEC     129
      DIMENSION XLABEL (2)                                     EXEC     130
      XK = 0.                                                  EXEC     131
      Y  =   FINTP1 (X,XI,YI,NX,XK,XLABEL)                     EXEC     132
      RETURN                                                   EXEC     133
      END                                                      EXEC     134
```

```
SUBROUTINE TABLE       74/74    OPT=1                          FTN 4.2+74355        07/07/75  11.07.34.       PAGE     2

         SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS      DEF LINE       REFERENCES
     3  TABLE          1              5

 VARIABLES        SN  TYPE               RELOCATION
       0  NX           INTEGER                  F.P.       REFS         4    DEFINED        1
       0  X            REAL                     F.P.       REFS         4    DEFINED        1
       0  XI           REAL                     F.P.       REFS         4    DEFINED        1
       0  XK           REAL                     F.P.       REFS         4    DEFINED        1
       0  XLABEL       REAL        ARRAY        F.P.       REFS         2         4    DEFINED        3
       0  Y            REAL                     F.P.     DEFINED        1         4                   1
       0  YI           REAL                     F.P.       REFS         4    DEFINED        1

 EXTERNALS              TYPE    ARGS         REFERENCES
        FINTP1          REAL      0              4

 STATISTICS
   PROGRAM LENGTH                     30B       24
```

```
SUBROUTINE TABL2       74/74    OPT=1                          FTN 4.2+74355       07/07/76   11.07.35.       PAGE     1

          SUBROUTINE TABL2(X,Y,XYI,ZI,NXY,XINTER,XLABEL,Z)                        EXEC       135
          DIMENSION XLABEL(2)                                                     EXEC       136
          DIMENSION XYI(2),NXY(2)                                                 EXEC       137
          Z =    FINTP2 (X,Y,XYI,XYI(NXY+1),ZI,NXY,NXY(2),NXY,XINTER,XLABEL)      EXEC       138
          RETURN                                                                  EXEC       139
          END                                                                     EXEC       140
```

```
      SUBROUTINE TABL2       74/74    OPT=1                           FTN 4.2+74355        07/07/76  11.07.35.        PAGE      2

      SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS       DEF LINE       REFERENCES
   3  TABL2             1              5

VARIABLES        SN  TYPE               RELOCATION
     0  NXY          INTEGER      ARRAY      F.P.          REFS           3           4*4   DEFINED         1
     0  X            REAL                    F.P.          REFS           4     DEFINED          1
     0  XINTER       REAL                    F.P.          REFS           4     DEFINED          1
     0  XLABEL       REAL         ARRAY      F.P.          REFS           2             4   DEFINED         1
     0  XYI          REAL         ARRAY      F.P.          REFS           3           2*4   DEFINED         1
     0  Y            REAL                    F.P.          REFS           4     DEFINED          1
     0  Z            REAL                    F.P.       DEFINED           1             4
     0  ZI           REAL                    F.P.         .REFS           4     DEFINED          1

EXTERNALS              TYPE    ARGS          REFERENCES
      FINTP2           REAL      10                  4

STATISTICS
  PROGRAM LENGTH                     40B       32
```

```
SUBROUTINE TABL3       74/74    OPT=1                          FTN 4.2+74355      07/07/75  11.07.36.       PAGE     1

                 SUBROUTINE TABL3(X,Y,Z,XYZI,WI,NXYZ,XINTER,XLABEL,W)                EXEC      141
                 DIMENSION XLABEL(2)                                                 EXEC      142
                 DIMENSION XYZI(1),NXYZ(1)                                           EXEC      143
                 NZI= NXYZ(1) + NXYZ(2) + 1                                          EXEC      144
                 XINTER = 0.                                                         EXEC      145
                 W  =    FINTP3 (X,Y,Z,XYZI,XYZI(NXYZ+1),XYZI(NZI), WI,NXYZ(3),      EXEC      146
                C   NXYZ(2),NXYZ,XINTER,XLABEL)                                      EXEC      147
                 RETURN                                                              EXEC      148
                 END                                                                 EXEC      149
```

```
      SUBROUTINE TABL3      74/74    OPT=1                        FTN 4.2+74355      07/07/76  11.07.36.       PAGE    2

      SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS       DEF LINE       REFERENCES
   3  TABL3            1              8

VARIABLES        SN  TYPE              RELOCATION
      0  NXYZ        INTEGER     ARRAY      F.P.        REFS        3        2*4        4*6   DEFINED        1
     47  NZI         INTEGER                            REFS        6    DEFINED         4
      0  N           REAL                   F.P.      DEFINED       1          5
      0  NI          REAL                   F.P.        REFS        6    DEFINED         1
      0  X           REAL                   F.P.        REFS        6    DEFINED         1
      0  XINTER      REAL                   F.P.        REFS        6    DEFINED         1         5
      0  XLABEL      REAL        ARRAY      F.P.        REFS        2          5    DEFINED        1
      0  XYZI        REAL        ARRAY      F.P.        REFS        3        3*6    DEFINED        1
      0  Y           REAL                   F.P.        REFS        6    DEFINED         1
      0  Z           REAL                   F.P.        REFS        6    DEFINED         1

EXTERNALS          TYPE     ARGS        REFERENCES
      FINTP3       REAL      12              6

STATISTICS
  PROGRAM LENGTH                  50B       40
```

```
FUNCTION FINTP1      74/74    OPT=1                          FTN 4.2+74355       07/07/75  11.07.36.       PAGE     1

                  FUNCTION FINTP1(X,XI,YI,N,F,XL)                             EXEC      150
                  DIMENSION XI(N), YI(N) , XL(2)                              EXEC      151
                  ENTRY CODIM2                                                EXEC      152
                  IF(F .GT. 0.)GO TO 30                                       EXEC      153
                  DO 10 I=2, N                                                EXEC      154
                  IF(X .LE. XI(I)) GO TO 20                                   EXEC      155
               10 CONTINUE                                                    EXEC      156
                  I = N                                                       EXEC      157
               20 PCT = (X-XI(I-1))/(XI(I)-XI(I-1))                           EXEC      158
                  F = 1.                                                      EXEC      159
               30 FINTP1 = YI(I-1) + PCT*(YI(I)-YI(I-1))                      EXEC      160
                  RETURN                                                      EXEC      161
                  END                                                         EXEC      162
```

```
      FUNCTION FINTP1      74/74    OPT=1                              FTN 4.2+74355       07/07/76  11.07.36.      PAGE     2

          SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS       DEF LINE      REFERENCES
     4  CODIM2          3             12
     4  FINTP1          1

 VARIABLES       SN  TYPE             RELOCATION
     0  F            REAL                  F.P.      REFS        4      DEFINED        1         10
    40  FINTP1       REAL                          DEFINED      11
    41  I            INTEGER                         REFS        6         3*9      3*11    DEFINED         5          8
     0  N            INTEGER               F.P.      REFS      2*2           5         8    DEFINED         1
    42  PCT          REAL                            REFS       11      DEFINED         9
     0  X            REAL                  F.P.      REFS        5           3   DEFINED         1
     0  XI           REAL         ARRAY    F.P.      REFS        2           5       3*9    DEFINED         1
     0  XL           REAL         ARRAY    F.P.      REFS        2      DEFINED         1
     0  YI           REAL         ARRAY    F.P.      REFS        2        3*11   DEFINED         1

 STATEMENT LABELS               DEF LINE    REFERENCES
     0  10                          7           5
    22  20                          9           6
    31  30                         11           4

 LOOPS  LABEL      INDEX       FROM-TO      LENGTH      PROPERTIES
    15  10          * I          2 7          33B        INSTACK      EXITS

 STATISTICS
   PROGRAM LENGTH                438         35
```

```
FUNCTION FINTP2      74/74    OPT=1                      FTN 4.2+74355      07/07/75  11.07.37.       PAGE     1

              FUNCTION FINTP2(X,Y,XI,YI,ZI,NXD,NY,NX,F,XL)                  EXEC       163
              DIMENSION XI(1),YI(1), ZI(NXD,1), T(2), XL(2)                 EXEC       164
              ENTRY FCODN2                                                  EXEC       165
              IF(F .GT. 0.) GO TO 30                                        EXEC       166
              DO 10 I=2, NY                                                 EXEC       167
              IF(Y .LE. YI(I)) GO TO 20                                     EXEC       168
           10 CONTINUE                                                      EXEC       169
              I = NY                                                        EXEC       170
           20 PCT = (Y-YI(I-1))/(YI(I)-YI(I-1))                             EXEC       171
           30 DO 40 J=1,2                                                   EXEC       172
              L = I + J - 2                                                 EXEC       173
           40 T(J) = FINTP1(X,XI,ZI(1,L),NX,F,XL)                           EXEC       174
              FINTP2 = T(1) + PCT*(T(2)-T(1))                               EXEC       175
              RETURN                                                        EXEC       176
              END                                                           EXEC       177
```

```
          SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE      REFERENCES
    4  FCODN2         3            14
    4  FINTP2         1

VARIABLES      SN  TYPE              RELOCATION
     0  F          REAL                   F.P.       REFS          4       12    DEFINED        1
    71  FINTP2     REAL                            DEFINED        13
    72  I          INTEGER                           REFS          6      3*9        11    DEFINED        5         8
    74  J          INTEGER                           REFS         11       12    DEFINED       10
    75  L          INTEGER                           REFS         12   DEFINED        11
     0  NX         INTEGER                F.P.       REFS         12   DEFINED         1
     0  NXO        INTEGER                F.P.       REFS          2   DEFINED         1
     0  NY         INTEGER                F.P.       REFS          5        3    DEFINED        1
    73  PCT        REAL                              REFS         13   DEFINED         9
    76  T          REAL       ARRAY                  REFS          2     3*13    DEFINED       12
     0  X          REAL                   F.P.       REFS         12   DEFINED         1
     0  XI         REAL       ARRAY       F.P.       REFS          2       12    DEFINED        1
     0  XL         REAL       ARRAY       F.P.       REFS          2       12    DEFINED        1
     0  Y          REAL                   F.P.       REFS          6        3    DEFINED        1
     0  YI         REAL       ARRAY       F.P.       REFS          2        5       3*9    DEFINED        1
     0  ZI         REAL       ARRAY       F.P.       REFS          2       12    DEFINED        1

EXTERNALS          TYPE    ARGS          REFERENCES
    FINTP1         REAL      5               12

STATEMENT LABELS                DEF LINE    REFERENCES
     0  10                          7            5
    26  20                          9            6
    33  30                         10            4
     0  40                         12           10

LOOPS  LABEL     INDEX      FROM-TO      LENGTH      PROPERTIES
   21  10        * I          5 7           38B       INSTACK      EXITS
   34  40        * J         10 12         208B                EXT REFS

STATISTICS
   PROGRAM LENGTH               100B        64
```

```
FUNCTION FINTP3      74/74    OPT=1                              FTN 4.2+74.335       07/07/75  11.07.38.        PAGE      1

      FUNCTION FINTP3(X,Y,Z,XI,YI,ZI,WI,NZ,NY,NX,F,XL)                     EXEC       178
      DIMENSION XI(1), YI(1), ZI(1), WI(NX,NY,1), T(2), XL(2)              EXEC       179
      ENTRY FCOON3                                                         EXEC       180
      DO 10 I=2, NZ                                                        EXEC       181
      IF(Z .LE. ZI(I)) GO TO 20                                            EXEC       182
   10 CONTINUE                                                             EXEC       183
      I = NZ                                                               EXEC       184
   20 PCT = (Z-ZI(I-1))/(ZI(I)-ZI(I-1))                                    EXEC       185
   30 DO 40 J=1,2                                                          EXEC       186
      L = I + J - 2                                                        EXEC       187
   40 T(J) = FINTP2(X,Y,XI,YI,WI(1,1,L),NX,NY,NX,F,XL)                     EXEC       188
      FINTP3 = T(1) + PCT*(T(2)-T(1))                                      EXEC       189
      RETURN                                                               EXEC       190
      END                                                                  EXEC       191
```

```
     FUNCTION FINTP3      74/74    OPT=1                            FTN 4.2+74355      07/07/75  11.07.38.     PAGE     2

          SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS       DEF LINE      REFERENCES
     4  FCOON3          3            13
     4  FINTP3          1

 VARIABLES       SN  TYPE             RELOCATION
     0  F            REAL                    F.P.      REFS         11   DEFINED        1
   101  FINTP3       REAL                            DEFINED        12
   102  I            INTEGER                           REFS          5       3*8       10    DEFINED        4         7
   104  J            INTEGER                           REFS         10        11   DEFINED        9
   105  L            INTEGER                           REFS         11   DEFINED       10
     0  NX           INTEGER                 F.P.      REFS          2      2*11   DEFINED        1
     0  NY           INTEGER                 F.P.      REFS          2        11   DEFINED        1
     0  NZ           INTEGER                 F.P.      REFS          4         7   DEFINED        1
   103  PCT          REAL                              REFS         12   DEFINED        8
   106  T            REAL        ARRAY                 REFS          2      3*12   DEFINED       11
     0  WI           REAL        ARRAY       F.P.      REFS          2        11   DEFINED        1
     0  X            REAL                    F.P.      REFS         11   DEFINED        1
     0  XI           REAL        ARRAY       F.P.      REFS          2        11   DEFINED        1
     0  XL           REAL        ARRAY       F.P.      REFS          2        11   DEFINED        1
     0  Y            REAL                    F.P.      REFS         11   DEFINED        1
     0  YI           REAL        ARRAY       F.P.      REFS          2        11   DEFINED        1
     0  Z            REAL                    F.P.      REFS          5         8   DEFINED        1
     0  ZI           REAL        ARRAY       F.P.      REFS          2         5       3*8    DEFINED        1

 EXTERNALS          TYPE    ARGS         REFERENCES
       FINTP2       REAL     10              11

 STATEMENT LABELS                 DEF LINE    REFERENCES
     0  10                            6           4
    25  20                            8           5
     0  30         INACTIVE           9
     0  40                           11           9

 LOOPS  LABEL     INDEX       FROM-TO     LENGTH     PROPERTIES
    20  10        * I          4  8         33       INSTACK    EXITS
    33  40        * J          9 11        25B                  EXT REFS

 STATISTICS
   PROGRAM LENGTH                1108        72
```

```
      SUBROUTINE DUMMY                                    EXEC  192
C     DUMMY SUBROUTINE                                    EXEC  193
      ENTRY A2I                                           EXEC  194
      ENTRY A4                                            EXEC  195
      ENTRY A4I                                           EXEC  196
      ENTRY A5                                            EXEC  197
      ENTRY A5I                                           EXEC  198
      ENTRY C2I                                           EXEC  199
      ENTRY C2                                            EXEC  200
      ENTRY C6                                            EXEC  201
      ENTRY C6I                                           EXEC  202
      ENTRY C7                                            EXEC  203
      ENTRY C7I                                           EXEC  204
      ENTRY C8                                            EXEC  205
      ENTRY C8I                                           EXEC  206
      ENTRY C9                                            EXEC  207
      ENTRY C9I                                           EXEC  208
      ENTRY C10                                           EXEC  209
      ENTRY C10I                                          EXEC  210
      ENTRY D3                                            EXEC  211
      ENTRY D3I                                           EXEC  212
      ENTRY D4                                            EXEC  213
      ENTRY D4I                                           EXEC  214
      ENTRY D5                                            EXEC  215
      ENTRY D5I                                           EXEC  216
      ENTRY G1                                            EXEC  217
      ENTRY G1I                                           EXEC  218
      ENTRY G3I                                           EXEC  219
      ENTRY G4I                                           EXEC  220
      ENTRY G5I                                           EXEC  221
      ENTRY G6                                            EXEC  222
      ENTRY G6I                                           EXEC  223
      ENTRY S5                                            EXEC  224
      ENTRY S5I                                           EXEC  225
      ENTRY S6                                            EXEC  226
      ENTRY S6I                                           EXEC  227
      ENTRY S7                                            EXEC  228
      ENTRY S7I                                           EXEC  229
      ENTRY S8I                                           EXEC  230
      ENTRY S9                                            EXEC  231
      ENTRY S9I                                           EXEC  232
      ENTRY S10                                           EXEC  233
      ENTRY S10I                                          EXEC  234
      ENTRY AUXA1                                         EXEC  235
      ENTRY AUXA2                                         EXEC  236
      ENTRY AUXA3                                         EXEC  237
      ENTRY AUXB1                                         EXEC  238
      ENTRY AUXB2                                         EXEC  239
      ENTRY AUXB3                                         EXEC  240
      ENTRY AUXC1                                         EXEC  241
      ENTRY AUXC2                                         EXEC  242
      ENTRY AUXC3                                         EXEC  243
      ENTRY CNTR1                                         EXEC  244
      ENTRY CNTR2                                         EXEC  245
      ENTRY CNTR3                                         EXEC  246
      ENTRY INPT1                                         EXEC  247
      ENTRY INPT2                                         EXEC  248
```

```
SUBROUTINE DUMMY        74/74    OPT=1                           FTN 4.2+74355        07/07/75  11.07.39.       PAGE     2

                     ENTRY INPT3                                                          EXEC      249
                     ENTRY OUPT1                                                          EXEC      250
                     ENTRY PROCES                                                         EXEC      251
                     ENTRY RNDM1                                                          EXEC      252
                     ENTRY RNDM2                                                          EXEC      253
                     ENTRY RNDM3                                                          EXEC      254
                     ENTRY STGE1                                                          EXEC      255
                     ENTRY KIKSET                                                         EXEC      256
                     ENTRY COUNTV                                                         EXEC      257
                     ENTRY TIMEV                                                          EXEC      258
                     ENTRY WRITE                                                          EXEC      259
                     RETURN                                                               EXEC      260
                     END                                                                  EXEC      261
```

```
       SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE      REFERENCES
     1  AUXA1         44
     1  AUXA2         45
     1  AUXA3         46
     1  AUXB1         47
     1  AUXB2         48
     1  AUXB3         49
     1  AUXC1         50
     1  AUXC2         51
     1  AUXC3         52
     1  A2I            3
     1  A4             4
     1  A4I            5
     1  A5             6
     1  A5I            7
     1  CNTR1         53
     1  CNTR2         54
     1  CNTR3         55
     1  COUNTV        66
     1  C10           18
     1  C10I          19
     1  C2             9
     1  C2I            8
     1  C6            10
     1  C6I           11
     1  C7            12
     1  C7I           13
     1  C8            14
     1  C8I           15
     1  C9            16
     1  C9I           17
     1  DUMMY          1
     1  D3            20
     1  D3I           21
     1  D4            22
     1  D4I           23
     1  D5            24
     1  D5I           25
     1  G1            26
     1  G1I           27
     1  G3I           28
     1  G4I           29
     1  G5I           30
     1  G6            31
     1  G6I           32
     1  INPT1         56
     1  INPT2         57
     1  INPT3         58
     1  KIKSET        65
     1  OUPT1         59
     1  PROCES        60
     1  RNDM1         61
     1  RNDM2         62
     1  RNDM3         63
     1  STGE1         64
```

```
      SUBROUTINE DUMMY        74/74    OPT=1                                   FTN 4.2+74355       07/07/75  11.07.39.        PAGE     4

   ENTRY POINTS        DEF LINE       REFERENCES
        1  S10            42
        1  S10I           43
        1  S5             33
        1  S5I            34
        1  S6             35
        1  S6I            36
        1  S7             37
        1  S7I            38
        1  S8I            39
        1  S9             40
        1  S9I            41
        1  TIMEV          67
        1  WRITE          68         69

   STATISTICS
     PROGRAM LENGTH                  33B       3
```

```
      SUBROUTINE TERROR (XLABEL)                                        EXEC    262
C**   FOR USE WITH CODIM2, FCN2, FCN3                                   EXEC    263
C                                                                       EXEC    264
      COMMON /C/ C(3838)                                                EXEC    265
      EQUIVALENCE (C(2020),LCONV)                                       EXEC    266
      WRITE (6,10) XLABEL                                               EXEC    267
   10 FORMAT ( 43H0        NO AERO POINTS SPECIFIED FOR ARS , 5X,       EXEC    268
     C   7HTABLE  ,A6 )                                                 EXEC    269
      CALL EXIT                                                         EXEC    270
      END                                                               EXEC    271
```

```
      SUBROUTINE TERROR      74/74    OPT=1                        FTN 4.2+74.355     07/07/75  11.07.39.      PAGE    2

      SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS      DEF LINE      REFERENCES
    3  TERROR          1            10

 VARIABLES      SN  TYPE             RELOCATION
    0  C            REAL       ARRAY   C             REFS      4       5
  5743  LCONV        INTEGER              C             REFS      5
    0  XLABEL       REAL                   F.P.         REFS      6    DEFINED        1

 FILE NAMES        MODE
      TAPE6        FMT                     WRITES         6

 EXTERNALS           TYPE   ARGS         REFERENCES
      EXIT                   0               9

 STATEMENT LABELS                DEF LINE    REFERENCES
    15  10      FMT                  7            6

 COMMON BLOCKS     LENGTH      MEMBERS - BIAS NAME(LENGTH)
      C             3830             0 C        (3830)

 EQUIV CLASSES     LENGTH      MEMBERS - BIAS NAME(LENGTH)
C     C             3830           2019 LCONV   (1)

 STATISTICS
   PROGRAM LENGTH                 25B       21
   CM LABELED COMMON LENGTH     7366B     3830
```

```
      SUBROUTINE AERROR (XLABEL)                                      EXEC   272
      COMMON /C/ C(3830)                                              EXEC   273
      EQUIVALENCE (C(2020),LCONV)                                     EXEC   274
      WRITE (6,20) XLABEL                                             EXEC   275
      RETURN                                                          EXEC   276
   20 FORMAT  ( 43H0         OUT OF AERO TABLE ARGUMENT ARRAY , 5X,   EXEC   277
     C   FHTABLE  ,A8 )                                               EXEC   278
      DO 40 I=1202,1251,7                                             EXEC   279
   40 WRITE(6,30) C(I),C(I+1),C(I+2),C(I+3),C(I+4),C(I+5),C(I+6)      EXEC   280
   30 FORMAT(1H ,7E15.7)                                              EXEC   281
      WRITE (6,30) C(2000),C(367),C(368),C(204),C(369),C(370),C(1117), EXEC  282
     C C(1118),C(1119),C(1120)                                        EXEC   283
      LCONV=2                                                         EXEC   284
      RETURN                                                          EXEC   285
      END                                                             EXEC   286
```

```
     SUBROUTINE AERROR      74/74    OPT=1                    FTN 4.2+74355       07/07/76  11.07.40.       PAGE    2

CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM

      6      I                THERE IS NO PATH TO THIS STATEMENT.
```

```
       SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS      DEF LINE      REFERENCES
     3  AERROR         1            5        14

 VARIABLES      SN  TYPE           RELOCATION
     0  C           REAL        ARRAY   C              REFS        2          3          7*9       10*11
   101  I           INTEGER                            REFS       7*9    DEFINED          8
  3743  LCONV       INTEGER             C              REFS        3     DEFINED         13
     0  XLABEL      REAL                   F.P.        REFS        4     DEFINED          1

 FILE NAMES         MODE
       TAPE6        FMT                   WRITES         4          9          11

 STATEMENT LABELS             DEF LINE   REFERENCES
    37  20       FMT              6          4
    61  30       FMT             10          9          11
     0  40                        9          8

 LOOPS  LABEL     INDEX      FROM-TO     LENGTH     PROPERTIES
    11  40        * I          8 9         17B                     EXT REFS

 COMMON BLOCKS    LENGTH      MEMBERS - BIAS NAME(LENGTH)
        C          3830               0 C       (3830)

 EQUIV CLASSES    LENGTH      MEMBERS - BIAS NAME(LENGTH)
C       C          3830            2019 LCONV  (1)

 STATISTICS
   PROGRAM LENGTH                 102B       66
   CM LABELED COMMON LENGTH      7366B     3830
```

```
FUNCTION SIND       74/74    OPT=1                    FTN 4.2+74355      07/07/75  11.07.41.      PAGE    1

                  FUNCTION SIND (X)                                        EXEC     287
                  SIND= SIN (X/57.29578)                                   EXEC     288
                  RETURN                                                   EXEC     289
                  END                                                      EXEC     290
```

```
FUNCTION SIND      74/74   OPT=1                        FTN 4.2+74355      07/07/76  11.07.41.      PAGE     2

        SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE     REFERENCES
    4  SIND           1             3

VARIABLES     SN  TYPE          RELOCATION
   12  SIND       REAL                          DEFINED        2
    0  X          REAL               F.P.        REFS          2    DEFINED       1

EXTERNALS           TYPE    ARGS        REFERENCES
       SIN          REAL      1 LIBRARY       2

STATISTICS
  PROGRAM LENGTH                  13B       11
```

```
FUNCTION COSD        74/74    OPT=1                    FTN 4.2+74355       07/07/75  11.07.41.        PAGE      1

                    FUNCTION COSD (X)                                      EXEC       291
                    COSD= COS (X/57.29578)                                 EXEC       292
                    RETURN                                                 EXEC       293
                    END                                                    EXEC       294
```

```
       SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS      DEF LINE      REFERENCES
     4  COSD            1             3

 VARIABLES      SN  TYPE             RELOCATION
    12  COSD        REAL                          DEFINED        2
     0  X           REAL                   F.P.      REFS        2   DEFINED        1

 EXTERNALS            TYPE    ARGS        REFERENCES
        COS           REAL       1 LIBRARY       2

 STATISTICS
   PROGRAM LENGTH                 13B      11
```

```
FUNCTION ATAND       74/74    OPT=1                    FTN 4.2+74355      07/07/76  11.07.41.      PAGE     1

              FUNCTION ATAND (Y,X)                                        EXEC       295
              ATAND= 57.29578*ATAN2 (Y,X)                                 EXEC       296
              RETURN                                                      EXEC       297
              END                                                         EXEC       298
```

```
      FUNCTION ATAND      74/74    OPT=1                         FTN 4.2+74355       07/07/75  11.07.41.        PAGE     2

        SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS       DEF LINE       REFERENCES
    4  ATAND              1             3

 VARIABLES       SN  TYPE            RELOCATION
   13  ATAND         REAL                          DEFINED        2
    0  X             REAL                 F.P.       REFS         2   DEFINED        1
    0  Y             REAL                 F.P.       REFS         2   DEFINED        1

 EXTERNALS               TYPE    ARGS          REFERENCES
        ATAN2        REAL          2 LIBRARY        2

 STATISTICS
   PROGRAM LENGTH                      1B       12
```

```
      SUBROUTINE S2I
      COMMON /C/ C(3838)
C
C **OCS SEEKER INITIALIZATION MODULE**
C
C
C**HIGH FREQUENCY SEEKER
      REAL KQ1,KQ2,KQ3,KQ4,KQ5,KQ6,KQ7,KQ8,KQ9,KQ10,KQ11,KQ12
      REAL KR1,KR2,KR3,KR4,KR5,KR6,KR7,KR8,KR9,KR10,KR11,KR12
      REAL KUO,KUI,KBO,KBI,KPO,KPI,KOAO,KOAI
      REAL JI,JO
      EQUIVALENCE (C( 545),    KQ1),  (C( 573),   WTQ1)
      EQUIVALENCE (C( 546),    KR1),  (C( 574),   WTR1)
      EQUIVALENCE (C( 547),    KQ2),  (C( 575),   WTQ2)
      EQUIVALENCE (C( 548),    KR2),  (C( 576),   WTR2)
      EQUIVALENCE (C( 549),    KQ3),  (C( 577),   WGQ1)
      EQUIVALENCE (C( 550),    KR3),  (C( 578),   WGR1)
      EQUIVALENCE (C( 551),    KQ5),  (C( 579),   WGQ2)
      EQUIVALENCE (C( 552),    KR5),  (C( 580),   WGR2)
      EQUIVALENCE (C( 553),    KQ6),  (C( 581),   WGQ3)
      EQUIVALENCE (C( 554),    KR5),  (C( 582),   WGR3)
      EQUIVALENCE (C( 555),    KQ7),  (C( 583),   WGQ4)
      EQUIVALENCE (C( 556),    KR7),  (C( 584),   WGR4)
      EQUIVALENCE (C( 557),    KQ8),  (C( 585),   WGQ5)
      EQUIVALENCE (C( 558),    KR8),  (C( 586),   WGR5)
      EQUIVALENCE (C( 559),   KQ10),  (C( 587),   WGQ6)
      EQUIVALENCE (C( 560),   KR10),  (C( 588),   WGR6)
      EQUIVALENCE (C( 561),   KQ11),  (C( 589),   WRQ1)
      EQUIVALENCE (C( 562),   KR11),  (C( 590),   WRR1)
      EQUIVALENCE (C( 563),   KQ12),  (C( 591),   WRQ2)
      EQUIVALENCE (C( 564),   KR12),  (C( 592),   WRR2)
      EQUIVALENCE (C( 565),     JI),  (C( 593),   WRQ3)
      EQUIVALENCE (C( 566),     JO),  (C( 594),   WRR3)
      EQUIVALENCE (C( 567),    FRI),  (C( 595),   WRQ4)
      EQUIVALENCE (C( 568),    FRO),  (C( 596),   WRR4)
      EQUIVALENCE (C( 569),    TUI),  (C( 597),    RCL)
      EQUIVALENCE (C( 570),    TUO),  (C( 598),   TCLQ)
      EQUIVALENCE (C( 571),   QERG),  (C( 599),   TCLR)
      EQUIVALENCE (C( 572),   RERG),  (C( 600),    TAU)
      EQUIVALENCE (C( 480),    GQ1),  (C( 482),    GQ2)
      EQUIVALENCE (C( 481),    GR1),  (C( 483),    GR2)
      EQUIVALENCE (C( 484),    GQ3),  (C( 486),    GQ4)
      EQUIVALENCE (C( 485),    GR3),  (C( 487),    GR4)
      EQUIVALENCE (C( 489),    GQ5),  (C( 491),    GQ6)
      EQUIVALENCE (C( 490),    GR5),  (C( 492),    GR6)
      EQUIVALENCE (C( 601),  TARHT),  (C( 602),  TARWD)
      EQUIVALENCE (C( 497),  GEOCS)
      EQUIVALENCE (C( 603), RBLOCC),  (C( 605),   IOCS)
      EQUIVALENCE (C( 601),  TARHT),  (C( 602),  TARWD)
      EQUIVALENCE (C( 604),   FFOV)
      EQUIVALENCE (C( 508), TDELAY),  (C( 609),   THTQ), (C( 610), THTR)
      EQUIVALENCE (C( 606),   TLAG)
C
C**INPUTS FROM OTHER MODULES**
      EQUIVALENCE (C(1751),    GRA)
      EQUIVALENCE (C( 371),  RANGE)
C
```

```
      C**STATE VARIABLES                                                S2   59
      C                                                                 S2   60
            EQUIVALENCE (C( 424), BTHTGD),  (C( 427),  BTHTS)           S2   61
            EQUIVALENCE (C( 428), BPSIGD),  (C( 431),  BPSIG)           S2   62
            EQUIVALENCE (C( 500),    DQ1),  (C( 503),     Q1)           S2   63
            EQUIVALENCE (C( 501),    DR1),  (C( 504),     R1)           S2   64
            EQUIVALENCE (C( 506),    DQ2),  (C( 509),     Q2)           S2   65
            EQUIVALENCE (C( 507),    DR2),  (C( 510),     R2)           S2   66
            EQUIVALENCE (C( 512),    DQ3),  (C( 515),     Q3)           S2   67
            EQUIVALENCE (C( 513),    DR3),  (C( 516),     R3)           S2   68
            EQUIVALENCE (C( 514),    DW0),  (C( 517),     W0)           S2   69
            EQUIVALENCE (C( 518),   DDQ4),  (C( 521),    DQ4), (C( 524),   Q4) S2   70
            EQUIVALENCE (C( 519),   DDR4),  (C( 522),    DR4), (C( 525),   R4) S2   71
            EQUIVALENCE (C( 520),    DWI),  (C( 523),     WI)           S2   72
            EQUIVALENCE (C( 527),   DDQ5),  (C( 530),    DQ5), (C( 533),   Q5) S2   73
            EQUIVALENCE (C( 528),   DDR5),  (C( 531),    DR5), (C( 534),   R5) S2   74
            EQUIVALENCE (C( 536),   DDQ6),  (C( 539),    DQ5), (C( 542),   Q6) S2   75
            EQUIVALENCE (C( 537),   DDR5),  (C( 540),    DR6), (C( 543),   R6) S2   76
      C                                                                 S2   77
      C**OUTPUTS                                                        S2   78
            EQUIVALENCE (C( 603), RBLOCK),  (C( 605),   IOCS)           S2   79
            EQUIVALENCE (C( 608), TDELAY),  (C( 609),   THTQ), (C( 510), THTR) S2   80
            EQUIVALENCE (C( 526),BEPSYSV)                               S2   81
            EQUIVALENCE (C( 529),BEPSZSV)                               S2   82
            EQUIVALENCE (C( 532), TIMESV)                               S2   83
            EQUIVALENCE (C(2561),      N),  (C(2562),    IPL)           S2   84
            EQUIVALENCE (C(2662), DERSV)                                S2   85
            EQUIVALENCE (C(3504),  OPTN4)                               S2   86
      C                                                                 S2   87
      C**MONTE CARLO PARAMETERS                                         S2   88
      C                                                                 S2   89
            EQUIVALENCE (C(3634),  ISNOX),  (C(3512),  I3512)           S2   90
            EQUIVALENCE (C( 611),    KU0),  (C( 612),    KUI)           S2   91
            EQUIVALENCE (C( 613),    KB0),  (C( 614),    KBI)           S2   92
            EQUIVALENCE (C( 615),    KP0),  (C( 616),    KPI)           S2   93
            EQUIVALENCE (C( 617),   KOAO),  (C( 618),   KOAI)           S2   94
            EQUIVALENCE (C( 619),    US0),  (C( 620),    USG)           S2   95
            EQUIVALENCE (C( 621),   UCCG),  (C( 622),   USCG)           S2   96
            DIMENSION IPL(100)                                          S2   97
            DIMENSION ISNOX(40)                                         S2   98
      C                                                                 S2   99
      C**NOMINAL SEEKER INPUT VALUES                                    S2  100
      C                                                                 S2  101
            DATA  KQ1,  KR1,  KQ2,  KR2,  KQ3.  KR3.  KQ5.  KR5,  KQ6   KR6  S2  102
           *                                                            S2  103
      C                                                                 S2  104
            DATA  KQ7,  KR7,  KQ8,  KR8, KQ10, KR10, KQ11, KR11, KQ12, KR12  S2  105
           *  /                                                         S2  106
      C                                                                 S2  107
            DATA WTQ1, WTR1, WTQ2, WTR2, WGQ1, WGR1, WGQ3, WGR3, WGQ4, WGR4  S2  108
           *  /                                                         S2  109
      C                                                                 S2  110
            DATA WGQ5, WGR5, WGQ6, WGR6, WRQ2, WRR2, WRQ4, WRR4         S2  111
           *                                         /                  S2  112
      C                                                                 S2  113
            DATA  RCL, TCLQ, TCLR,   JI,    IO.GPOCS,  FRI,  FRJ        S2  114
           *                                         /                  S2  115
```

SUBROUTINE S2I   74/74   OPT=1   FTN 4.2+74355   07/07/75 11.07.42.   PAGE   3

```
      C
            DATA FFOV,TARHT,TARWD,  TAU,  AGV,CFREQ,  KUI,  KUO,  KPO,  KPI
           .  /
      C
            DATA   KBO,    KBI,   KOAO,   KOAI
           .  /
      C

            IS3=0
      C
      C
            IF(D(2664).GT..0005)WRITE(6,112)
        112 FORMAT(1H1,15(/),10X,*INTEGRATION STEPSIZE IS GREATER THAN THE REC
           .OMMENDED VALUE FOR SEEKER MODEL S2.*/,11X,*RECOMMENDED VALUE IS .0
           $005 SEC. CHECK RESULTS FOR VALIDITY.*,10(/))
      C
      C
            GO TO 10
      C
      C
            ENTRY S3I
      C**LOW FREQUENCY SEEKER
      C
            IPL(N)=500
            IS3=1
            IPL(N+1)=501
            IPL(N+2)=506
            IPL(N+3)=507
            IPL(N+4)=512
            IPL(N+5)=513
            IPL(N+6)=514
            IPL(N+7)=520
            IPL(N+8)=424
            IPL(N+9)=428
            N=N+10
            GO TO 20
         10 CONTINUE
            IPL(N)=500
            IPL(N+1)=501
            IPL(N+2)=506
            IPL(N+3)=507
            IPL(N+4)=512
            IPL(N+5)=513
            IPL(N+6)=514
            IPL(N+7)=518
            IPL(N+8)=519
            IPL(N+9)=520
            IPL(N+10)=521
            IPL(N+11)=522
            IPL(N+12)=527
            IPL(N+13)=528
            IPL(N+14)=530
            IPL(N+15)=531
            IPL(N+16)=536
            IPL(N+17)=537
            IPL(N+18)=539
            IPL(N+19)=540
```

```
                IPL(N+20)=424                                                     S2    173
                IPL(N+21)=428                                                     S2    174
                N=N+22                                                            S2    175
          20    CONTINUE                                                          S2    176
                DO 1 I=500,543                                                    S2    177
          1     C(I)=0.                                                           S2    178
          C*****FILL TRANSPORT LAG (TLAG) ARRAYS                                  S2    179
                C(655)=C(2000)-C(2664)                                            S2    180
                DO 7 I=1,6                                                        S2    181
                C(655-I)=C(656-I)-C(2664)                                         S2    182
                C(655+I)=0.                                                       S2    183
                C(651+I)=0.                                                       S2    184
          7     CONTINUE                                                          S2    185
                C(13)=-1.                                                         S2    186
                C(451)=0.                                                         S2    187
                C(452)=0.                                                         S2    188
                C(453)=0.                                                         S2    189
                C(454)=0.                                                         S2    190
                IF(SPTN4.GT.1.) GO TO 3                                           S2    191
                C(451)=1.                                                         S2    192
                C(452)=1.                                                         S2    193
                C(453)=1.                                                         S2    194
                C(454)=1.                                                         S2    195
          3     CONTINUE                                                          S2    196
                TDELAY=0.     $ THTQ=0.     $   THTR=0.                           S2    197
                C(403)=0.      $ C(407)=0.      $ C(424)=0.      $ C(428)=0.      S2    198
                C(435)=0.      $ C(436)=0.                                        S2    199
                C(630)=0.      $ C(631)=0.                                        S2    200
                DERSV=.002                                                        S2    201
                BEPSYSV=0.                                                        S2    202
                BEPSZSV=0.                                                        S2    203
                TUI=0.                                                            S2    204
                TUO=0.                                                            S2    205
                GQ1=KQ1*KQ2/CRAD                                                  S2    206
                GR1=KR1*KR2/CRAD                                                  S2    207
                GQ2=KQ3*WTQ2/WTQ1                                                 S2    208
                GR2=KR3*WTR2/WTR1                                                 S2    209
                GQ3=KQ5*WGQ6*WGQ5*WGQ4/(WGQ1*WGQ3*WGQ5)                           S2    210
                GR3=KR5*WGR6*WGR5*WGR4/(WGR1*WGR3*WGR5)                           S2    211
                GQ4=KQ6*KQ7                                                       S2    212
                GR4=KR6*KR7                                                       S2    213
                GQ5=KQ10*WRQ2*WR12/CRAD                                           S2    214
                GR5=KR10*WRR2*WRR2/CRAD                                           S2    215
                GQ6=KQ11*WRQ4*WRQ4                                                S2    216
                GR6=KR11*WRR4*WRR4                                                S2    217
                RANGE=SQRT(C(1635)*C(1635)+C(1636)*C(1636)+C(1637)*C(1637))       S2    218
                THTQ=ATAND(TARHT,RANGE)/2.                                        S2    219
                THTR=ATAND(TARWD,RANGE)/2.                                        S2    220
                IOCS=-10                                                          S2    221
          C                                                                       S2    222
                IF(IS3.EQ.0) GO TO 6                                              S2    223
                GQ3=KQ5*WGQ4/WGQ1/WGQ3                                            S2    224
                GR3=KR5*WGR4/WGR1/WGR3                                            S2    225
                GQ5=KQ10*KQ11/CRAD                                                S2    226
                GR5=KR10*KR11/CRAD                                                S2    227
          6     CONTINUE                                                          S2    228
          C                                                                       S2    229
```

```
      DO 30 I=1,13512
      IDO=I
C
C**MONTE CARLO MASS UNBALANCE ON SEEKER GYRO
C
      IF(ISNDX(I).EQ.611)CALL MCARLO(DUM, 1, IDO)
      IF(ISNDX(I).EQ.611)CALL RANNUM(0.,RNSTRT,RN)
      KUO=SIGN(KUO,RN)
      IF(ISNDX(I).EQ.612)CALL MCARLO(DUM, 1, IDO)
      IF(ISNDX(I).EQ.612)CALL RANNUM(0.,RNSTRT,RN)
      CHI=360.*RN
C
C**MONTE CARLO SEEKER RATE GYRO ERRORS
C
      IF(ISNDX(I).EQ.613)CALL MCARLO(DUM, 1, IDO)
      IF(ISNDX(I).EQ.614)CALL MCARLO(DUM, 1, IDO)
      IF(ISNDX(I).EQ.615)CALL MCARLO(DUM, 1, IDO)
      IF(ISNDX(I).EQ.615)CALL RANNUM(0.,RNSTRT,RN)
      CHIG=360.*RN
      IF(ISNDX(I).EQ.616)CALL MCARLO(DUM, 1, IDO)
      IF(ISNDX(I).EQ.617)CALL MCARLO(DUM, 1, IDO)
      IF(ISNDX(I).EQ.618)CALL MCARLO(DUM, 1, IDO)
      UCC=COSD(CHI)
      USC=SIND(CHI)
      UCCG=COSD(CHIG)
      USCG=SIND(CHIG)
   30 CONTINUE
      RETURN
      END
```

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      SUBROUTINE S2I        74/74    OPT=1                        FTN 4.2+74355      07/07/75  11.07.42.      PAGE     6

      SYMBOLIC REFERENCE MAP (R=3)

 ENTRY POINTS      DEF LINE      REFERENCES
    1  S2I            1
   11  S3I          135         256

 VARIABLES       SN  TYPE             RELOCATION
   361  AGV       *  REAL                          DEFINED      116
  1015  BEPSYSV      REAL                  C         REFS        80   DEFINED     201
  1020  BEPSZSV      REAL                  C         REFS        81   DEFINED     202
   656  BPSIG        REAL                  C         REFS        61
   653  BPSIGD       REAL                  C         REFS        61
   652  BTHTG        REAL                  C         REFS        60
   647  BTHTGD       REAL                  C         REFS        60
     0  C            REAL        ARRAY     C         REFS         2   2*12     2*13     2*14     2*15     2*16     2*17
                                                    2*18      2*19   2*20     2*21     2*22     2*23     2*24     2*25
                                                    2*26      2*27   2*28     2*29     2*30     2*31     2*32     2*33
                                                    2*34      2*35   2*36     2*37     2*38     2*39     2*40     2*41
                                                    2*42      2*43   2*44     2*45     2*46     47       2*48     2*49
                                                      50      3*51   52       55       56       2*60     2*61     2*62
                                                    2*63      2*64   2*65     2*66     2*67     2*68     3*69     3*70
                                                    2*71      3*72   3*73     3*74     3*75     2*78     3*79     80
                                                      81        82   2*83     84       85       2*89     2*90     2*91
                                                    2*92      2*93   2*94     2*95     126      2*179    2*181    6*217
                                                 DEFINED       177   179      181      182      183      185      186
                                                     187       188   189      191      192      193      194      4*197
                                                   2*198     2*199
   362  CFREQ     *  REAL                          DEFINED      116
   432  CHI          REAL                            REFS       251   252      DEFINED  239
   433  CHIG         REAL                            REFS       253   254      DEFINED  247
  1326  CRAD         REAL                  C         REFS        55   205      206      213      214      225      226
  1005  DDQ4         REAL                  C         REFS        69
  1016  DDQ5         REAL                  C         REFS        72
  1027  DDQ6         REAL                  C         REFS        74
  1006  DDR4         REAL                  C         REFS        70
  1017  DDR5         REAL                  C         REFS        73
  1030  DDR6         REAL                  C         REFS        75
  5145  DERSV        REAL                  C         REFS        84   DEFINED     200
   763  DQ1          REAL                  C         REFS        62
   771  DQ2          REAL                  C         REFS        64
   777  DQ3          REAL                  C         REFS        66
  1010  DQ4          REAL                  C         REFS        69
  1021  DQ5          REAL                  C         REFS        72
  1032  DQ6          REAL                  C         REFS        74
   764  DR1          REAL                  C         REFS        63
   772  DR2          REAL                  C         REFS        65
  1000  DR3          REAL                  C         REFS        67
  1011  DR4          REAL                  C         REFS        70
  1022  DR5          REAL                  C         REFS        73
  1033  DR6          REAL                  C         REFS        75
   427  DU4          REAL                            REFS       234   237      243      244      245      248      249
                                                     250
  1007  DWI          REAL                  C         REFS        71
  1001  DWO          REAL                  C         REFS        68
  1133  FFOV         REAL                  C         REFS        59   DEFINED     116
  1066  FRI          REAL                  C         REFS        34   DEFINED     113
  1067  FRO          REAL                  C         REFS        35   DEFINED     113
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        SUBROUTINE S2I         74/74    OPT=1                          FTN 4.2+74355      07/07/75  11.07.42.      PAGE     7

 VARIABLES         SN  TYPE              RELOCATION
      760  GEOCS       REAL                  C          REFS        47    DEFINED       113
      737  GQ1         REAL                  C          REFS        40    DEFINED       205
      741  GQ2         REAL                  C          REFS        40    DEFINED       207
      743  GQ3         REAL                  C          REFS        42    DEFINED       209        223
      745  GQ4         REAL                  C          REFS        42    DEFINED       211
      750  GQ5         REAL                  C          REFS        44    DEFINED       213        225
      752  GQ6         REAL                  C          REFS        44    DEFINED       215
      740  GR1         REAL                  C          REFS        41    DEFINED       206
      742  GR2         REAL                  C          REFS        41    DEFINED       208
      744  GR3         REAL                  C          REFS        43    DEFINED       210        224
      746  GR4         REAL                  C          REFS        43    DEFINED       212
      751  GR5         REAL                  C          REFS        45    DEFINED       214        226
      753  GR6         REAL                  C          REFS        45    DEFINED       216
      425  I           INTEGER                          REFS       177      2*181       182        183        230        234        235
                                                         237       238        243       244        245        246        248        249
                                                         250   DEFINED        175       180        229
      426  IDO         INTEGER                          REFS       234        237       243        244        245        248        249
                                                         250   DEFINED        230
     1134  IO3S        INTEGER               C          REFS        40         70   DEFINED        228
     3001  IPL         INTEGER     ARRAY     C          REFS        83         95   DEFINED        138        140        141        142
                                                         143       144        145       146        147        148        152        153
                                                         154       155        155       157        158        159        160        161
                                                         162       163        164       165        166        167        168        169
                                                         170       171        172       173
     7061  ISNDX       INTEGER     ARRAY     C          REFS        89         97       234        235        237        238        243
                                                         244       245        246       248        249        250
      424  IS3         INTEGER                          REFS       222    DEFINED       123        139
     3667  I3512       INTEGER               C          REFS        89        229
     1064  JI          REAL                  C          REFS        11         32   DEFINED        113
     1065  JO          REAL                  C          REFS        11         33   DEFINED        113
     1145  K0I         REAL                  C          REFS        10         91   DEFINED        119
     1144  K0O         REAL                  C          REFS        10         91   DEFINED        119
     1151  KOAI        REAL                  C          REFS        10         93   DEFINED        119
     1150  KOAO        REAL                  C          REFS        10         93   DEFINED        119
     1147  KPI         REAL                  C          REFS        10         92   DEFINED        116
     1146  KPO         REAL                  C          REFS        10         92   DEFINED        116
     1040  KQ1         REAL                  C          REFS         8         12       205    DEFINED        101
     1056  KQ10        REAL                  C          REFS         8         26       213        225    DEFINED        104
     1060  KQ11        REAL                  C          REFS         8         28       215        225    DEFINED        104
     1062  KQ12        REAL                  C          REFS         8         30   DEFINED        104
     1042  KQ2         REAL                  C          REFS         8         14       205    DEFINED        101
     1044  KQ3         REAL                  C          REFS         8         16       207    DEFINED        101
      420  KQ4       * REAL       *UNDEF                REFS         8
     1046  KQ5         REAL                  C          REFS         8         18       209        223    DEFINED        101
     1050  KQ6         REAL                  C          REFS         8         20       211    DEFINED        101
     1052  KQ7         REAL                  C          REFS         8         22       211    DEFINED        104
     1054  KQ8         REAL                  C          REFS         8         24   DEFINED        104
      421  KQ9       * REAL       *UNDEF                REFS         8
     1041  KR1         REAL                  C          REFS         9         13       206    DEFINED        101
     1057  KR10        REAL                  C          REFS         9         27       214        226    DEFINED        104
     1061  KR11        REAL                  C          REFS         9         29       218        226    DEFINED        104
     1063  KR12        REAL                  C          REFS         9         31   DEFINED        104
     1043  KR2         REAL                  C          REFS         9         15       206    DEFINED        101
     1045  KR3         REAL                  C          REFS         9         17       208    DEFINED        101
      422  KR4       * REAL       *UNDEF                REFS         9
     1047  KR5         REAL                  C          REFS         9         19       210        224    DEFINED        101
     1051  KR6         REAL                  C          REFS         9         21       212    DEFINED        101
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AD-A032 048 ARMY MISSILE RESEARCH DEVELOPMENT AND ENGINEERING LAB--ETC F/G 16/4
THAD T-7 MISSILE MONTE-CARLO TERMINAL HOMING SIMULATION UTILIZI--ETC(U)
JUL 76 C L LEWIS, W R HOOKER, A W LEE

UNCLASSIFIED RG-7T-2 NL

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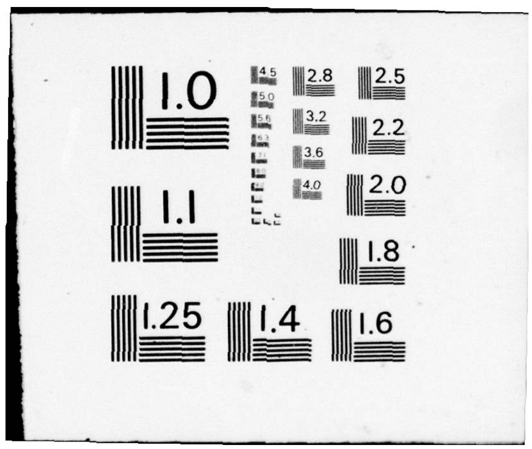
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5.0

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VARIABLES       SN  TYPE              RELOCATION
  1053  KR7          REAL                  C          REFS      9     23     212   DEFINED    104
  1055  KR8          REAL                  C          REFS      9     25   DEFINED    104
   423  KR9      *   REAL        *UNDEF               REFS      9
  1143  KUI          REAL                  C          REFS     10     90   DEFINED    116
  1142  KUD          REAL                  C          REFS     10     90     236   DEFINED    116    236
  5000  N            INTEGER               C          REFS     83    133     140     141    142    143    144
                                                       145    146    147     148     149    152    153    154
                                                       155    156    157     158     159    160    161    162
                                                       163    164    165     166     167    168    169    170
                                                       171    172    173     174   DEFINED    149    174
  5657  OPTN4        REAL                  C          REFS     85    190
  1072  QERG         REAL                  C          REFS     38
   766  Q1           REAL                  C          REFS     62
   774  Q2           REAL                  C          REFS     64
  1002  Q3           REAL                  C          REFS     66
  1013  Q4           REAL                  C          REFS     69
  1024  Q5           REAL                  C          REFS     72
  1035  Q6           REAL                  C          REFS     74
   562  RANGE        REAL                  C          REFS     56    210     219   DEFINED    217
  1132  RBLOCK       REAL                  C          REFS     48     79
  1124  RCL          REAL                  C          REFS     36  DEFINED     113
  1073  RERG         REAL                  C          REFS     39
   431  RN           REAL                             REFS    235    235     238     239    246    247
   430  RNSTRT       REAL                             REFS    235    239     246
   767  R1           REAL                  C          REFS     63
   775  R2           REAL                  C          REFS     65
  1003  R3           REAL                  C          REFS     67
  1014  R4           REAL                  C          REFS     70
  1025  R5           REAL                  C          REFS     73
  1036  R6           REAL                  C          REFS     75
  1130  TARHT        REAL                  C          REFS     46     49     218   DEFINED    116
  1131  TARHO        REAL                  C          REFS     46     49     219   DEFINED    116
  1127  TAJ          REAL                  C          REFS     39  DEFINED     116
  1125  TCLQ         REAL                  C          REFS     37  DEFINED     113
  1126  TCLR         REAL                  C          REFS     38  DEFINED     113
  1137  TDELAY       REAL                  C          REFS     51     79   DEFINED     196
  1140  THTQ         REAL                  C          REFS     51     79   DEFINED     196    218
  1141  THTR         REAL                  C          REFS     51     79   DEFINED     196    219
  1023  TIMESV       REAL                  C          REFS     62
  1135  TLAG         REAL                  C          REFS     52
  1070  TUI          REAL                  C          REFS     36  DEFINED     203
  1071  TUD          REAL                  C          REFS     37  DEFINED     204
  1152  UCD          REAL                  C          REFS     94  DEFINED     251
  1154  UCDG         REAL                  C          REFS     95  DEFINED     253
  1153  USD          REAL                  C          REFS     94  DEFINED     252
  1155  USDG         REAL                  C          REFS     95  DEFINED     254
  1100  WGQ1         REAL                  C          REFS     16    209     223   DEFINED    107
  1102  WGQ2         REAL                  C          REFS     18
  1104  WGQ3         REAL                  C          REFS     20    209     223   DEFINED    107
  1106  WGQ4         REAL                  C          REFS     22    209     223   DEFINED    107
  1110  WGQ5         REAL                  C          REFS     24    209   DEFINED     110
  1112  WGQ6         REAL                  C          REFS     26  2*209   DEFINED     110
  1101  WGR1         REAL                  C          REFS     17    210     224   DEFINED    107
  1103  WGR2         REAL                  C          REFS     19
  1105  WGR3         REAL                  C          REFS     21    210     224   DEFINED    107
  1107  WGR4         REAL                  C          REFS     23    210     224   DEFINED    107
  1111  WGR5         REAL                  C          REFS     25    210   DEFINED     110
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        SUBROUTINE S2I          74/74    OPT=1                         FTN 4.2+74355      07/07/75  11.07.42.      PAGE    9

VARIABLES        SN  TYPE             RELOCATION
    1113  WGR6        REAL                C            REFS       27      2*210   DEFINED      110
    1012  WI          REAL                C            REFS       71
    1004  WO          REAL                C            REFS       68
    1114  WR21        REAL                C            REFS       28
    1116  WR22        REAL                C            REFS       30      2*213   DEFINED      110
    1120  WR23        REAL                C            REFS       32
    1122  WR24        REAL                C            REFS       34      2*215   DEFINED      110
    1115  WRR1        REAL                C            REFS       29
    1117  WRR2        REAL                C            REFS       31      2*214   DEFINED      110
    1121  WRR3        REAL                C            REFS       33
    1123  WRR4        REAL                C            REFS       35      2*216   DEFINED      110
    1074  WT21        REAL                C            REFS       12       207    DEFINED      107
    1076  WT22        REAL                C            REFS       14       207    DEFINED      107
    1075  WTR1        REAL                C            REFS       13       208    DEFINED      107
    1077  WTR2        REAL                C            REFS       15       208    DEFINED      107

FILE NAMES          MODE
         TAPE6      FMT                   WRITES       126

EXTERNALS           TYPE     ARGS          REFERENCES
         ATAND      REAL      2               218        219
         COSD       REAL      1               251        253
         MCARLO               3               234        237        243        244        245        248        249        250
         RANNUM               3               235        238        246
         SIND       REAL      1               252        254
         SQRT       REAL      1 LIBRARY       217

INLINE FUNCTIONS    TYPE     ARGS          DEF LINE   REFERENCES
         SIGN       REAL      2  INTRIN                  236

STATEMENT LABELS                  DEF LINE    REFERENCES
     0  1                           177         176
   132  3                           195         190
   236  6                           227         222
     0  7                           184         180
    36  10                          151         132
   101  20                          175         150
     0  30                          255         229
   366  112         FMT             127         126

LOOPS   LABEL     INDEX      FROM-TO      LENGTH      PROPERTIES
   103  1           I        176 177        20          INSTACK
   113  7         * I        180 184        70          INSTACK
   237  30        * I        229 255       770                      EXT REFS

COMMON BLOCKS     LENGTH      MEMBERS - BIAS NAME(LENGTH)
         C          3830                 0 C       (3830)

EQUIV CLASSES     LENGTH      MEMBERS - BIAS NAME(LENGTH)
C        C          3830             370 RANGE   (1)               423 BTHTGD  (1)               426 BTHTG   (1)
                                     427 BPSIGD  (1)               430 BPSIG   (1)               479 GQ1     (1)
                                     480 GR1     (1)               481 GQ2     (1)               482 GR2     (1)
                                     483 GR3     (1)               484 GR3     (1)               485 GQ4     (1)
                                     486 GR4     (1)               488 GQ5     (1)               489 GR5     (1)
                                     490 GQ6     (1)               491 GR6     (1)               495 GEOCS   (1)
                                     499 DQ1     (1)               500 DR1     (1)               502 Q1      (1)
                                     503 R1      (1)               505 DQ2     (1)               506 DR2     (1)
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SUBROUTINE S21        74/74    OPT=1                          FTN 4.2+74355        07/07/75  11.07.42.        PAGE    10

EQUIV CLASSES   LENGTH      MEMBERS - BIAS NAME(LENGTH)
                                 508 Q2      (1)            509 R2      (1)            511 DQ3     (1)
                                 512 DR3     (1)            513 DWO     (1)            514 Q3      (1)
                                 515 R3      (1)            516 WO      (1)            517 DDQ4    (1)
                                 518 DDR4    (1)            519 DWI     (1)            520 DQ4     (1)
                                 521 DR4     (1)            522 WI      (1)            523 Q4      (1)
                                 524 R4      (1)            525 BEPSYSV(1)             526 DDQ5    (1)
                                 527 DDR5    (1)            528 BEPSZSV(1)             529 DQ5     (1)
                                 530 DR5     (1)            531 TIMESV  (1)            532 Q5      (1)
                                 533 R5      (1)            535 DDQ5    (1)            536 DDR5    (1)
                                 538 DQ6     (1)            539 DR5     (1)            541 Q6      (1)
                                 542 R6      (1)            544 KQ1     (1)            545 KR1     (1)
                                 546 KQ2     (1)            547 KR2     (1)            548 KQ3     (1)
                                 549 KR3     (1)            550 KQ5     (1)            551 KR5     (1)
                                 552 KQ6     (1)            553 KR6     (1)            554 KQ7     (1)
                                 555 KR7     (1)            556 KQ8     (1)            557 KR8     (1)
                                 558 KQ10    (1)            559 KR10    (1)            560 KQ11    (1)
                                 561 KR11    (1)            562 KQ12    (1)            563 KR12    (1)
                                 564 JI      (1)            565 JO      (1)            566 FRI     (1)
                                 567 PRO     (1)            568 TUI     (1)            569 TUO     (1)
                                 570 QERG    (1)            571 RERG    (1)            572 WTQ1    (1)
                                 573 WTR1    (1)            574 WTQ2    (1)            575 WTR2    (1)
                                 576 WGQ1    (1)            577 WGR1    (1)            578 WGQ2    (1)
                                 579 WGR2    (1)            580 WGQ3    (1)            581 WGR3    (1)
                                 582 WGQ4    (1)            583 WGR4    (1)            584 WGQ5    (1)
                                 585 WGR5    (1)            586 WGQ6    (1)            587 WGR6    (1)
                                 588 WRQ1    (1)            589 WRR1    (1)            590 WRQ2    (1)
                                 591 WRR2    (1)            592 WRQ3    (1)            593 WRR3    (1)
                                 594 WRQ4    (1)            595 WRR4    (1)            596 RCL     (1)
                                 597 TCLQ    (1)            598 TCLR    (1)            599 TAU     (1)
                                 600 TARHT   (1)            601 TARWD   (1)            602 RBLOCK  (1)
                                 603 FFOV    (1)            604 IOOS    (1)            605 TLAG    (1)
                                 607 TDELAY  (1)            608 THTQ    (1)            609 THTR    (1)
                                 610 KJO     (1)            611 KUI     (1)            612 KBO     (1)
                                 613 KBI     (1)            614 KPO     (1)            615 KPI     (1)
                                 616 KOAO    (1)            617 KOAI    (1)            618 UCC     (1)
                                 619 USC     (1)            620 UCCS    (1)            621 USCS    (1)
                                1750 CRAD    (1)           2560 N       (1)           2551 IPL     (100)
                                2661 DERSV   (1)           3503 OPTN4   (1)           3511 I3512   (1)
                                3633 ISNDX   (40)

STATISTICS
  PROGRAM LENGTH               434B      284
  CM LABELED COMMON LENGTH   73660B    3830
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C ** OCS SEEKER MODULE**                                              S2      261
C                                                                     S2      262
C                                                                     S2      263
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C                                                                     S2      266
C                                                                     S2      267
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C..................OR LESS WHEN RUNNING WITH SEEKER MODEL S3.......... S2    270
C                                                                     S2      271
C                                                                     S2      272
C                                                                     S2      273
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      REAL KR1,KR2,KR3,KR4,KR5,KR6,KR7,KR8,KR9,KR10,KR11,KR12         S2      276
      REAL KQO,KQI,KRO,KRI,KPO,KPI,KOAO,KOAI                          S2      277
      REAL JI,JO                                                      S2      278
C**INPUT DATA                                                         S2      279
      EQUIVALENCE (C( 545),     KQ1),  (C( 573),    WTQ1)             S2      280
      EQUIVALENCE (C( 546),     KR1),  (C( 574),    WTR1)             S2      281
      EQUIVALENCE (C( 547),     KQ2),  (C( 575),    WTQ2)             S2      282
      EQUIVALENCE (C( 548),     KR2),  (C( 576),    WTR2)             S2      283
      EQUIVALENCE (C( 549),     KQ3),  (C( 577),    WGQ1)             S2      284
      EQUIVALENCE (C( 550),     KR3),  (C( 578),    WGR1)             S2      285
      EQUIVALENCE (C( 551),     KQ5),  (C( 579),    WGQ2)             S2      286
      EQUIVALENCE (C( 552),     KR5),  (C( 580),    WGR2)             S2      287
      EQUIVALENCE (C( 553),     KQ5),  (C( 581),    WGQ3)             S2      288
      EQUIVALENCE (C( 554),     KR5),  (C( 582),    WGR3)             S2      289
      EQUIVALENCE (C( 555),     KQ7),  (C( 583),    WGQ4)             S2      290
      EQUIVALENCE (C( 556),     KR7),  (C( 584),    WGR4)             S2      291
      EQUIVALENCE (C( 557),     KQ8),  (C( 585),    WGQ5)             S2      292
      EQUIVALENCE (C( 558),     KR8),  (C( 586),    WGR5)             S2      293
      EQUIVALENCE (C( 559),    KQ10),  (C( 587),    WGQ5)             S2      294
      EQUIVALENCE (C( 560),    KR10),  (C( 588),    WGR5)             S2      295
      EQUIVALENCE (C( 561),    KQ11),  (C( 589),    WRQ1)             S2      296
      EQUIVALENCE (C( 562),    KR11),  (C( 590),    WRR1)             S2      297
      EQUIVALENCE (C( 563),    KQ12),  (C( 591),    WRQ2)             S2      298
      EQUIVALENCE (C( 564),    KR12),  (C( 592),    WRR2)             S2      299
      EQUIVALENCE (C( 565),      JI),  (C( 593),    WRQ3)             S2      300
      EQUIVALENCE (C( 566),      JO),  (C( 594),    WRR3)             S2      301
      EQUIVALENCE (C( 567),     FRI),  (C( 595),    WRQ4)             S2      302
      EQUIVALENCE (C( 568),     FRO),  (C( 596),    WRR4)             S2      303
      EQUIVALENCE (C( 569),     TUI),  (C( 597),     RCL)             S2      304
      EQUIVALENCE (C( 570),     TUO),  (C( 598),    TCLQ)             S2      305
      EQUIVALENCE (C( 571),    QERG),  (C( 599),    TCLR)             S2      306
      EQUIVALENCE (C( 572),    RERG),  (C( 600),     TAU)             S2      307
      EQUIVALENCE (C( 480),     GQ1),  (C( 482),     GQ2)             S2      308
      EQUIVALENCE (C( 481),     GR1),  (C( 483),     GR2)             S2      309
      EQUIVALENCE (C( 484),     GQ3),  (C( 486),     GQ4)             S2      310
      EQUIVALENCE (C( 485),     GR3),  (C( 487),     GR4)             S2      311
      EQUIVALENCE (C( 489),     GQ5),  (C( 491),     GQ6)             S2      312
      EQUIVALENCE (C( 490),     GR5),  (C( 492),     GR5)             S2      313
      EQUIVALENCE (C( 497),   GEOCS)                                  S2      314
      EQUIVALENCE (C( 603), RBLOCK),   (C( 605),    IOCS)             S2      315
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      EQUIVALENCE (C( 601),  TARMT),  (C( 602),  TARM3)                      S2        316
      EQUIVALENCE (C( 604),   FFOV)                                          S2        317
      EQUIVALENCE (C( 608), TDELAY),  (C( 609),    THTQ),  (C( 610),  THTR)  S2        318
      EQUIVALENCE (C( 606),   TLAG)                                          S2        319
C                                                                            S2        320
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      EQUIVALENCE (C( 372),   RXBA)                                          S2        322
      EQUIVALENCE (C( 373),   RYBA)                                          S2        323
      EQUIVALENCE (C( 374),   RZBA)                                          S2        324
      EQUIVALENCE (C(1739),     WP)                                          S2        325
      EQUIVALENCE (C(1743),     WQ)                                          S2        326
      EQUIVALENCE (C(1747),     WR)                                          S2        327
      EQUIVALENCE (C(1751),   CRAD)                                          S2        328
      EQUIVALENCE (C(2000),   TIME)                                          S2        329
      EQUIVALENCE (C( 371),  RANGE)                                          S2        330
      EQUIVALENCE (C(1676),   ANGX)                                          S2        331
      EQUIVALENCE (C(1677),   ANGY)                                          S2        332
      EQUIVALENCE (C(1678),   ANGZ)                                          S2        333
      EQUIVALENCE (C(1736),    WPD)                                          S2        334
      EQUIVALENCE (C(1740),    WQD)                                          S2        335
      EQUIVALENCE (C(1744),    WRD)                                          S2        336
      EQUIVALENCE (C( 650),TIMESV)                                           S2        337
      EQUIVALENCE (C( 656),   LOSZ)                                          S2        338
      EQUIVALENCE (C( 662),   LOSY)                                          S2        339
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      DIMENSION TIMESV(6),LOSZ(6),LOSY(6),XL(2)                              S2        341
C                                                                            S2        342
C**STATE VARIABLES                                                           S2        343
      EQUIVALENCE (C( 424), BTHTGD),  (C( 427),   BTHTG)                     S2        344
      EQUIVALENCE (C( 428), BPSIGD),  (C( 431),   BPSIG)                     S2        345
      EQUIVALENCE (C( 500),    DQ1),  (C( 503),      Q1)                     S2        346
      EQUIVALENCE (C( 501),    DR1),  (C( 504),      R1)                     S2        347
      EQUIVALENCE (C( 506),    DQ2),  (C( 509),      Q2)                     S2        348
      EQUIVALENCE (C( 507),    DR2),  (C( 510),      R2)                     S2        349
      EQUIVALENCE (C( 512),    DQ3),  (C( 515),      Q3)                     S2        350
      EQUIVALENCE (C( 513),    DR3),  (C( 516),      R3)                     S2        351
      EQUIVALENCE (C( 514),    DW3),  (C( 517),      W3)                     S2        352
      EQUIVALENCE (C( 518),   DDQ4),  (C( 521),     DQ4),  (C( 524),    Q4)  S2        353
      EQUIVALENCE (C( 519),   DDR4),  (C( 522),     DR4),  (C( 525),    R4)  S2        354
      EQUIVALENCE (C( 520),    DWI),  (C( 523),      WI)                     S2        355
      EQUIVALENCE (C( 527),   DDQ5),  (C( 530),     DQ5),  (C( 533),    Q5)  S2        356
      EQUIVALENCE (C( 528),   DDR5),  (C( 531),     DR5),  (C( 534),    R5)  S2        357
      EQUIVALENCE (C( 536),   DDQ5),  (C( 539),     DQ5),  (C( 542),    Q6)  S2        358
      EQUIVALENCE (C( 537),   DDR5),  (C( 540),     DR5),  (C( 543),    R6)  S2        359
C                                                                            S2        360
C**OTHER OUTPUTS                                                             S2        361
      EQUIVALENCE (C( 435),  BEPSZ)                                          S2        362
      EQUIVALENCE (C( 436),  BEPSY)                                          S2        363
      EQUIVALENCE (C( 403),  WLAMQ)                                          S2        364
      EQUIVALENCE (C( 407),  WLAMR)                                          S2        365
      EQUIVALENCE (C( 526),BEPSYSV)                                          S2        366
      EQUIVALENCE (C( 529),BEPSZSV)                                          S2        367
      EQUIVALENCE (C( 493),  DTHCQ),  (C( 494),   DTHCR)                     S2        368
      EQUIVALENCE (C( 495), DTHRGQ),  (C( 496),  DTHRGR)                     S2        369
      EQUIVALENCE (C(2020),  LGONV),  (C( 625),     IBL)                     S2        370
      EQUIVALENCE (C( 607),  BRLKQ)                                          S2        371
C                                                                            S2        372
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C**MONTE CARLO PARAMETERS
C
      EQUIVALENCE (C(3634)),  ISNDX),  (C(3512),  I3512)
      EQUIVALENCE (C( 611),    KUO),   (C( 612),    KUI)
      EQUIVALENCE (C( 613),    KBO),   (C( 614),    KBI)
      EQUIVALENCE (C( 615),    KPO),   (C( 616),    KPI)
      EQUIVALENCE (C( 617),   KOAO),   (C( 618),   KOAI)
      EQUIVALENCE (C( 619),    UCC),   (C( 620),    USC)
      EQUIVALENCE (C( 621),   UCCG),   (C( 622),   USCG)
      DATA FOV/4./
C
C INTEGRATION SWITCHING TEST
C             SYNCHRONIZE INTEGRATION WITH SAMPLE SIZE
      IF(C(13).LE.0.)GO TO 1
      C(13)=-1.
      C(2864)=TAU/AINT(TAU/C(2764))
    1 CONTINUE
C
C**DIRECTION COSINES FOR BODY TO PLATFORM TRANSFORMATION
      UCT=COSD(BTHTG)
      UST=SIND(BTHTG)
      UCP=COSD(BPSIG)
      USP=SIND(BPSIG)
      UB11=UCT*UCP
      UB12=USP
      UB13=-UCP*UST
      UB21=-UCT*USP
      UB22=UCP
      UB23=UST*USP
      UB31=UST
      UB32=0.
      UB33=UCT
C
C**TRANSFORM LOS FROM BODY TO GIMBAL AXES
      RXG=UB11*RXBA+UB12*RYBA+UB13*RZBA
      RYG=UB21*RXBA+UB22*RYBA+UB23*RZBA
      RZG=UB31*RXBA+UB32*RYBA+UB33*RZBA
      IF(I3512.LE.0)GO TO 5
C**GYRO ERRORS
C
C**TRANSFORM NORMALIZED ACCELERATIONS FROM BODY TO GIMBAL AXES
      ANGXG=UB11*ANGX+UB12*ANGY+UB13*ANGZ
      ANGYG=UB21*ANGX+UB22*ANGY+UB23*ANGZ
      ANGZG=UB31*ANGX+UB32*ANGY+UB33*ANGZ
      ANG=ANGZG*UCCG-ANGYG*USCG
      QERG=KBO+KPO*ANG+KOAO*WPO
      RERG=KBI+KPI*ANG+KOAI*WPO
      TUO=KUO*(ANGX*UCT-ANGZ*UST)
      TUI=KUI*(ANGYG*USC-ANGXG*USC)
    5 CONTINUE
C
C**LOS ERRORS IN PLATFORM COORDINATES
      IF(C(1975).LE.0.)GO TO 32
      BEPSZ=ATAND(-RZG,RXG)
      BEPSY=ATAND( RYG,RXG)
C**SAVE EVERY FIFTH  POINT OF BEPSZ AND BEPSY FOR TLAG
      ILAG=ILAG+1
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```
      IF(ILAG.LT.5)GO TO 4                                        S2   430
      ILAG=0                                                      S2   431
      DO 2 L=2,6                                                  S2   432
      TIMESV(L-1)=TIMESV(L)                                       S2   433
      LOSZ(L-1)=LOSZ(L)                                           S2   434
      LOSY(L-1)=LOSY(L)                                           S2   435
    2 CONTINUE                                                    S2   436
    4 CONTINUE                                                    S2   437
      TIMESV(6)=TIME                                              S2   438
      LOSZ(6)=BEPSZ                                               S2   439
      LOSY(6)=BEPSY                                               S2   440
   32 CONTINUE                                                    S2   441
C                                                                 S2   442
C        TRACKER LOOP                                             S2   443
C                                                                 S2   444
C                                                                 S2   445
C**ZOH (TDELAY..TAU) AND TIME DELAY (TLAG)                        S2   446
      IF(TIME.LT.(TDELAY-.00001).OR.C(1976).LE.0.)GO TO 10        S2   447
      TDELAY=TIME+TAU                                             S2   448
      THTQ=ATAND(TARHT/2.,RANGE)                                  S2   449
      THTR=ATAND(TARWD/2.,RANGE)                                  S2   450
      BRLKQ=(BEPSZ-BEPSZSV)/(2.*THTQ)                             S2   451
      BRLKR=(BEPSY-BEPSYSV)/(2.*THTR)                             S2   452
      TTLAG=TIME-TLAG   $  N=6   $  F=0.                          S2   453
      BEPSZSV=FINTP1(    TTLAG,TIMESV,LOSZ,N,F,XL)                S2   454
      BEPSYSV=FINTP1(    TTLAG,TIMESV,LOSY,N,F,XL)                S2   455
      IF(ABS(BRLKQ) .LT. .5 .AND. ABS(BRLKR) .LT. .5)GO TO 30     S2   456
C**BREAKLOCK DETERMINATION                                        S2   457
      IF(IOCS.NE.-10)GO TO 30                                     S2   458
      IOCS=-9                                                     S2   459
      IBL=IBL+1                                                   S2   460
      LCONV=2                                                     S2   461
      WHICH = 10H IN PITCH                                        S2   462
      IF(ABS(BRLKR) .GE. .5)WHICH = 10H IN YAW                    S2   463
      WRITE(6,101)TIME,RANGE,WHICH                                S2   464
  101 FORMAT(1H0,100(1H*)/* BREAK LOCK CONDITION AT TIME = *F5.2, S2   465
     + * RANGE = *F10.2,A10,/100(1H*))                            S2   466
   30 CONTINUE                                                    S2   467
      DELAYQ=GQ1*BEPSZSV                                          S2   468
      DELAYR=GR1*BEPSYSV                                          S2   469
      DQ1=     DELAYQ-WTQ2*Q1                                     S2   470
      DR1=     DELAYR-WTR2*R1                                     S2   471
      DTHCQ=(DQ1+WTQ1*Q1)*GQ2                                     S2   472
      DTHCR=(DR1+WTR1*R1)*GR2                                     S2   473
C        RATE COMMAND LIMIT                                       S2   474
      IF(ABS(DTHCQ).GT.RCL)DTHCQ=SIGN(RCL,DTHCQ)                  S2   475
      IF(ABS(DTHCR).GT.RCL)DTHCR=SIGN(RCL,DTHCR)                  S2   476
C                                                                 S2   477
C        RATE GYRO LOOP                                           S2   478
C                                                                 S2   479
      W1Q=WQ*UCP-(WP*UCT-WR*UST)*USP                              S2   480
      DDQ5=    (W1Q+QERS)-WRQ2*DQ5-WRQ2*WRQ2*Q5                   S2   481
      DDR5=    (WI+RERS)-WRR2*DR5-WRR2*WRR2*R5                    S2   482
      DDQ5=GQ5*Q5-WRQ4*DQ6-WRQ4*WRQ4*Q6                           S2   483
      DDR5=GR5*R5-WRR4*DR6-WRR4*WRR4*R6                           S2   484
      DTHRGQ=KQ12*Q6*SQ6                                          S2   485
      DTHRGR=KR12*R6*SR6                                          S2   486
```

```
      C
      C
      C** BLIND RANGE DETERMINATION
            THTOAQ=THTQ+ABS(BEPSZ)
            THTOAR=THTR+ABS(BEPSY)
            BLNDQ=THTOAQ*2./FOV
            BLNDR=THTOAR*2./FOV
            TESTFOV=FFOV*FOV/2.
            IF(THTOAQ.LT.TESTFOV.AND.THTOAR.LT.TESTFOV) GO TO 20
            IF(IOCS.LE.0)WRITE(6,100)TIME,RANGE
        100 FORMAT(1H0,100(1H*)/* OCS BLIND RANGE SIGNAL HOLD AT TIME = *F5.2,
           + *  RANGE = *F10.2/100(1H*))
            IOCS=10
            GO TO 21
         20 CONTINUE
            WLAMQ=Q6*GQ6*GEOCS
            WLAMR=R6*GR6*GEOCS
            IF(ABS(C(630)).LT.ABS(BRLKQ))C(630)=BRLKQ
            IF(ABS(C(631)).LT.ABS(BRLKR))C(631)=BRLKR
         21 CONTINUE
      C
      C         GAIN COMPENSATION
      C
            DTHTEQ=DTHCQ-DTHRGQ
            DTHTER=DTHCR-DTHRGR
            DQ2=      DTHTEQ
            DR2=      DTHTER
            DQ3=DQ2+WGQ1*Q2-WGQ4*Q3
            DR3=DR2+WGR1*R2-WGR4*R3
            DDQ4=DQ3+WGQ3*Q3-WGQ6*DQ4-WGQ6*WGQ6*Q4
            DDR4=DR3+WGR3*R3-WGR6*DR4-WGR6*WGR6*R4
      C
      C         SEEKER TORQUE MOTOR
      C
            TQ=(WGQ5*Q4+DQ4)*GQ3
            TR=(WGR5*R4+DR4)*GR3
            IF(ABS(TQ).GT.TCLQ)TQ=SIGN(TCLQ,TQ)
            IF(ABS(TR).GT.TCLR)TR=SIGN(TCLR,TR)
            TMQ=GQ4*TQ
            TMR=GR4*TR
      C
      C         SEEKER GIMBAL ANGLE RATES
      C
      C**COULOMB FRICTION MODEL
            TCOMQ=KQ8*BTHTG/CRAD
            IF(ABS(BTHTGD).LE.4.E-4)GO TO 70
            TFQ=                    SIGN(FRO,BTHTGD)
            TAQ=TMQ-TFQ-TCOMQ-TUO
            DWO=TAQ*CRAD/JO
            GO TO 73
         70 CONTINUE
            TFQ=TMQ-TCOMQ-TUO
            IF(ABS(TFQ).GT.FRO)TFQ=SIGN(FRO,TMQ)
            WCOQ=(TFQ+SIGN(FRO,WQD))*CRAD/JO
            DWBAQ=WQD
            IF(ABS(WQD).GT.ABS(WCOQ))DWBAQ=WCOQ
            TAQ=TMQ-TFQ-TCOMQ-TUO
```

```
      DWAQ=TAQ/JO*CRAD
      DWO=DWBAQ+DWAQ
   73 CONTINUE
      TCOMR=KR8*BPSIG/CRAD
      IF(ABS(BPSIGD).LE.4.E-4)GO TO 80
      TFR=SIGN(FRI,BPSIGD)
      TAR=TMR-TFR-TCOMR-TUI
      DWI=TAR*CRAD/JI
      GO TO 83
   80 CONTINUE
      WRES=UCT*WRD+UST*WPD
      TFR=TMR-TCOMR-TUI
      IF(ABS(TFR).GT.FRI)TFR=SIGN(FRI,TMR)
      WCOR=(TFR+SIGN(FRI,WRES))*CRAD/JI
      DWBAR=WRES
      IF(ABS(WRES).GT.ABS(WCOR))DWBAR=WCOR
      TAR=TMR-TFR-TCOMR-TUI
      DWAR=TAR/JI*CRAD
      DWI=DWBAR+DWAR
   83 CONTINUE
      BTHTGD=WJ-WQ
      BPSIGD=WI-(WR*UCT+WP*UST)
    3 CONTINUE
      RETURN
      END
```

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      SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS        DEF LINE       REFERENCES
   1  S2                1           309

VARIABLES        SN  TYPE            RELOCATION
   703  ANG          REAL                            REFS        160       161    DEFINED       159
  3213  ANGX         REAL                   C        REFS         73       155       157        158      162
   700  ANGXG        REAL                            REFS        163   DEFINED       156
  3214  ANGY         REAL                   C        REFS         74       155       157        158
   701  ANGYG        REAL                            REFS        159       163    DEFINED       157
  3215  ANGZ         REAL                   C        REFS         75       155       157        158      162
   702  ANGZG        REAL                            REFS        159   DEFINED       158
   663  BEPSY        REAL                   C        REFS        105       182       134        233   DEFINED      169
  1015  BEPSYSV      REAL                   C        REFS        108       194       211    DEFINED      197
   662  BEPSZ        REAL                   C        REFS        104       181       133        232   DEFINED      168
  1020  BEPSZSV      REAL                   C        REFS        109       193       210    DEFINED      196
   720  BENDQ      * REAL                         DEFINED       234
   721  BENDR      * REAL                         DEFINED       235
   656  BPSIG        REAL                   C        REFS         87       135       137        289
   653  BPSIGD       REAL                   C        REFS         87       290       291    DEFINED      307
  1136  BRLKQ        REAL                   C        REFS        113       193     2*246    DEFINED      193
   706  BRLKR        REAL                            REFS        198       205     2*247    DEFINED      194
   652  BTHTG        REAL                   C        REFS         86       134       135        273
   647  BTHTGD       REAL                   C        REFS         85       274       275    DEFINED      306
     0  C            REAL        ARRAY      C        REFS         16      2*22      2*23       2*24     2*25     2*26     2*27
                                                     2*28       2*29      2*30      2*31       2*32     2*33     2*34     2*35
                                                     2*36       2*37      2*38      2*39       2*40     2*41     2*42     2*43
                                                     2*44       2*45      2*46      2*47       2*48     2*49     2*50     2*51
                                                     2*52       2*53      2*54      2*55         56     2*57     2*58       59
                                                     3*60         61        64        65         66       67       68       69
                                                       70         71        72        73         74       75       76       77
                                                       78         79        80        81       2*86     2*87     2*88     2*89
                                                     2*90       2*91      2*92      2*93       2*94     3*95     3*96     2*97
                                                     3*98       3*99     3*100     3*101        104      105      106      107
                                                      108        109     2*110     2*111      2*112      113    2*117    2*118
                                                    2*119      2*120     2*121     2*122      2*123      124      130      167
                                                      189        246       247   DEFINED        129      130      246      247
  3326  CRAD         REAL                   C        REFS         70       278       277        282      286      289      293
                                                      299        303
  1005  DD14         REAL                   C        REFS         95   DEFINED       258
  1016  DD15         REAL                   C        REFS         98   DEFINED       223
  1027  DD16         REAL                   C        REFS        100   DEFINED       225
  1006  DDR4         REAL                   C        REFS         96   DEFINED       259
  1017  DDR5         REAL                   C        REFS         99   DEFINED       224
  1030  DDR6         REAL                   C        REFS        101   DEFINED       226
   713  DELAYQ       REAL                            REFS        212   DEFINED       210
   714  DELAYR       REAL                            REFS        213   DEFINED       211
   763  DQ1          REAL                   C        REFS         88       214    DEFINED       212
   771  DQ2          REAL                   C        REFS         90       255    DEFINED       254
   777  DQ3          REAL                   C        REFS         92       258    DEFINED       256
  1010  DQ4          REAL                   C        REFS         95       255       263
  1021  DQ5          REAL                   C        REFS         98       223
  1032  DQ6          REAL                   C        REFS        100       225
   764  DR1          REAL                   C        REFS         89       216    DEFINED       213
   772  DR2          REAL                   C        REFS         91       257    DEFINED       255
  1000  DR3          REAL                   C        REFS         93       259    DEFINED       257
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VARIABLES		SN	TYPE	RELOCATION							
1011	DR4		REAL	C	REFS	96	259	264			
1022	DR5		REAL	C	REFS	99	224				
1033	DR6		REAL	C	REFS	101	226				
754	DTHCQ		REAL	C	REFS	110	2*217	252	DEFINED	214	217
755	DTHCR		REAL	C	REFS	110	2*218	253	DEFINED	215	218
756	DTHRGQ		REAL	C	REFS	111	252	DEFINED	227		
757	DTHRGR		REAL	C	REFS	111	253	DEFINED	228		
723	DTHTEQ		REAL		REFS	254	DEFINED	252			
724	DTHTER		REAL		REFS	255	DEFINED	253			
736	DWAQ		REAL		REFS	287	DEFINED	286			
745	DWAR		REAL		REFS	304	DEFINED	303			
735	DW3AQ		REAL		REFS	287	DEFINED	283	284		
744	DW3AR		REAL		REFS	304	DEFINED	300	301		
1007	DWI		REAL	C	REFS	97	DEFINED	293	304		
1001	DWO		REAL	C	REFS	94	DEFINED	277	287		
711	F		REAL		REFS	196	197	DEFINED	195		
1133	FFOV		REAL	C	REFS	59	235				
504	FOV		REAL		REFS	234	235	236	DEFINED	124	
1066	FRI		REAL	C	REFS	44	291	2*290	299		
1067	FRO		REAL	C	REFS	45	275	2*281	282		
760	GEOCS		REAL	C	REFS	56	244	245			
737	GQ1		REAL	C	REFS	50	210				
741	GQ2		REAL	C	REFS	50	214				
743	GQ3		REAL	C	REFS	52	263				
745	GQ4		REAL	C	REFS	52	267				
750	GQ5		REAL	C	REFS	54	225				
752	GQ6		REAL	C	REFS	54	227	244			
740	GR1		REAL	C	REFS	51	211				
742	GR2		REAL	C	REFS	51	215				
744	GR3		REAL	C	REFS	53	264				
746	GR4		REAL	C	REFS	53	269				
751	GR5		REAL	C	REFS	55	225				
753	GR6		REAL	C	REFS	55	229	245			
1160	IBL		INTEGER	C	REFS	112	202	DEFINED	202		
704	ILAG		INTEGER		REFS	171	172	DEFINED	171	173	
1134	IOCS		INTEGER	C	REFS	57	200	238	DEFINED	201	241
7061	ISNDX		INTEGER	C	REFS	117					
5567	I3512		INTEGER	C	REFS	117	152				
1064	JI		REAL	C	REFS	20	42	293	299	303	
1065	JO		REAL	C	REFS	20	43	277	282	286	
1145	KBI		REAL	C	REFS	19	119	161			
1144	KBO		REAL	C	REFS	19	119	160			
1151	KOAI		REAL	C	REFS	19	121	161			
1150	KOAO		REAL	C	REFS	19	121	160			
1147	KPI		REAL	C	REFS	19	120	161			
1146	KPO		REAL	C	REFS	19	120	160			
1040	KQ1		REAL	C	REFS	17	22				
1056	KQ10		REAL	C	REFS	17	35				
1060	KQ11		REAL	C	REFS	17	39				
1062	KQ12		REAL	C	REFS	17	40	227			
1042	KQ2		REAL	C	REFS	17	24				
1044	KQ3		REAL	C	REFS	17	25				
654	KQ4	*	REAL	*UNDEF	REFS	17					
1046	KQ5		REAL	C	REFS	17	23				
1050	KQ6		REAL	C	REFS	17	30				
1052	KQ7		REAL	C	REFS	17	32				
1054	KQ8		REAL	C	REFS	17	34	273			

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      SUBROUTINE S2          74/74    OPT=1                              FTN 4.2+74355        07/07/75  11.07.46.         PAGE      9

VARIABLES         SN  TYPE             RELOCATION
   655  KQ3       *  REAL         *UNDEF              REFS        17
  1041  KR1          REAL                    C        REFS        18         23
  1057  KR10         REAL                    C        REFS        18         37
  1061  KR11         REAL                    C        REFS        18         33
  1063  KR12         REAL                    C        REFS        18         41        228
  1043  KR2          REAL                    C        REFS        18         25
  1045  KR3          REAL                    C        REFS        18         27
   656  KR4       *  REAL         *UNDEF              REFS        18
  1047  KR5          REAL                    C        REFS        18         29
  1051  KR6          REAL                    C        REFS        18         31
  1053  KR7          REAL                    C        REFS        18         33
  1055  KR8          REAL                    C        REFS        18         35        289
   657  KR9       *  REAL         *UNDEF              REFS        18
  1143  KJI          REAL                    C        REFS        19        113        163
  1142  KUD          REAL                    C        REFS        19        118        162
   705  L            INTEGER                          REFS     2*175      2*176      2*177     DEFINED      178
  3743  LCONV        INTEGER                 C        REFS       112     DEFINED       203
  1225  LOSY         REAL         ARRAY      C        REFS        81         82         83         177        197
                                                   DEFINED       177        182
  1217  LOSZ         REAL         ARRAY      C        REFS        80         82         83         176        196
                                                   DEFINED       176        181
   710  N            INTEGER                          REFS       196        197      DEFINED       195
  1072  QERS         REAL                    C        REFS        48        223      DEFINED       160
   766  Q1           REAL                    C        REFS        88        212        214
   774  Q2           REAL                    C        REFS        90        256
  1002  Q3           REAL                    C        REFS        92        256        258
  1013  Q4           REAL                    C        REFS        95        253        253
  1024  Q5           REAL                    C        REFS        98        223        225
  1035  Q6           REAL                    C        REFS       100        225        227         244
   562  RANGE        REAL                    C        REFS        72        191        192         206        238
  1132  RBLOCK       REAL                    C        REFS        57
  1124  RCL          REAL                    C        REFS        46      2*217      2*218
  1073  RERG         REAL                    C        REFS        49        224      DEFINED       161
   563  RX3A         REAL                    C        REFS        64        149        150         151
   675  RX5          REAL                             REFS       168        169      DEFINED       149
   564  RYBA         REAL                    C        REFS        65        149        150         151
   676  RY5          REAL                             REFS       169     DEFINED       150
   565  RZ3A         REAL                    C        REFS        66        149        150         151
   677  RZ5          REAL                             REFS       168     DEFINED       151
   767  R1           REAL                    C        REFS        89        213        215
   775  R2           REAL                    C        REFS        91        257
  1003  R3           REAL                    C        REFS        93        257        259
  1014  R4           REAL                    C        REFS        96        259        264
  1025  R5           REAL                    C        REFS        99        224        226
  1036  R6           REAL                    C        REFS       101        226        226         245
   733  TAJ          REAL                             REFS       277        285      DEFINED       276        285
   741  TAR          REAL                             REFS       293        303      DEFINED       292        302
  1130  TARHT        REAL                    C        REFS        58        191
  1131  TARND        REAL                    C        REFS        58        192
  1127  TAJ          REAL                    C        REFS        49      2*130        190
  1125  TCLQ         REAL                    C        REFS        47      2*265
  1126  TCLR         REAL                    C        REFS        48      2*256
   731  TCOMQ        REAL                             REFS       275        280        285     DEFINED      278
   737  TCOMR        REAL                             REFS       292        297        302     DEFINED      289
  1137  TDELAY       REAL                    C        REFS        48        189      DEFINED       190
   722  TESTFOV      REAL                             REFS     2*237     DEFINED       236
   732  TFJ          REAL                             REFS       276        281        282         285     DEFINED      275      280
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VARIABLES          SN  TYPE        RELOCATION
                                                    281
   740  TFR            REAL                         REFS        292      293      299      302   DEFINED    291      297
                                                    298
   716  THTOAQ         REAL                         REFS        234      237  DEFINED      232
   717  THTOAR         REAL                         REFS        235      237  DEFINED      233
  1140  THTQ           REAL                 C       REFS         60      193      232  DEFINED      191
  1141  THTR           REAL                 C       REFS         60      194      233  DEFINED      192
  3717  TIME           REAL                 C       REFS         71      180      189      190      195      206      238
  1211  TIMESV         REAL         ARRAY   C       REFS         79       83      175      196      197
                                                 DEFINED        175      180
  1135  TLAG           REAL                 C       REFS         61      195
   727  TMQ            REAL                         REFS        276      280      281      285   DEFINED    267
   730  TMR            REAL                         REFS        292      297      298      302   DEFINED    268
   725  TQ             REAL                         REFS      2*265      267  DEFINED      263      265
   726  TR             REAL                         REFS      2*266      268  DEFINED      264      266
   707  TT_AG          REAL                         REFS        196      197  DEFINED      195
  1070  TUI            REAL                 C       REFS         46      292      297      302   DEFINED    163
  1071  TUO            REAL                 C       REFS         47      275      280      285   DEFINED    162
   664  UB11           REAL                         REFS        149      155  DEFINED      138
   665  UB12           REAL                         REFS        149      156  DEFINED      139
   666  UB13           REAL                         REFS        149      155  DEFINED      140
   667  UB21           REAL                         REFS        150      157  DEFINED      141
   670  UB22           REAL                         REFS        150      157  DEFINED      142
   671  UB23           REAL                         REFS        150      157  DEFINED      143
   672  UB31           REAL                         REFS        151      153  DEFINED      144
   673  UB32           REAL                         REFS        151      158  DEFINED      145
   674  UB33           REAL                         REFS        151      158  DEFINED      146
  1152  UCC            REAL                 C       REFS        122      163
  1154  UCCG           REAL                 C       REFS        123      159
   662  UCP            REAL                         REFS        138      140      142      222   DEFINED    136
   660  UCT            REAL                         REFS        138      141      146      162      222      296      307
                                                 DEFINED        134
  1153  USC            REAL                 C       REFS        122      163
  1155  USCG           REAL                 C       REFS        123      159
   663  USP            REAL                         REFS        139      141      143      222   DEFINED    137
   661  UST            REAL                         REFS        140      143      144      162      222      296      307
                                                 DEFINED        135
   734  WCOQ           REAL                         REFS      2*284  DEFINED      282
   743  WCOR           REAL                         REFS      2*301  DEFINED      299
  1100  WG11           REAL                 C       REFS         26      255
  1102  WG12           REAL                 C       REFS         28
  1104  WG13           REAL                 C       REFS         30      258
  1106  WG14           REAL                 C       REFS         32      256
  1110  WG15           REAL                 C       REFS         34      263
  1112  WG16           REAL                 C       REFS         36    3*258
  1101  WGR1           REAL                 C       REFS         27      257
  1103  WGR2           REAL                 C       REFS         29
  1105  WGR3           REAL                 C       REFS         31      259
  1107  WGR4           REAL                 C       REFS         33      257
  1111  WGR5           REAL                 C       REFS         35      264
  1113  WGR6           REAL                 C       REFS         37    3*259
   712  WHICH          REAL                         REFS        205  DEFINED      204      205
  1012  WI             REAL                 C       REFS         97      224      307
   622  WLAMQ          REAL                 C       REFS        106  DEFINED      244
   626  WLAMR          REAL                 C       REFS        107  DEFINED      245
  1004  WO             REAL                 C       REFS         94      222      306
  1312  WP             REAL                 C       REFS         67      222      307
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      SUBROUTINE S2          74/74    OPT=1                        FTN 4.2+74355       07/07/75  11.07.46.       PAGE    11

VARIABLES      SN  TYPE            RELOCATION
   3307  WP3        REAL                 C           REFS         76        160        161        296
   3316  WQ         REAL                 C           REFS         68        305
   3313  WQ3        REAL                 C           REFS         77        282        283        284
   3322  WR         REAL                 C           REFS         69        222        307
   3317  WR3        REAL                 C           REFS         78        296
    742  WRES       REAL                             REFS        299        300        301     DEFINED      296
   1114  WR11       REAL                 C           REFS         38
   1116  WR12       REAL                 C           REFS         40      3*223
   1120  WR13       REAL                 C           REFS         42
   1122  WR24       REAL                 C           REFS         44      3*225
   1115  WRR1       REAL                 C           REFS         39
   1117  WRR2       REAL                 C           REFS         41      3*224
   1121  WRR3       REAL                 C           REFS         43
   1123  WRR4       REAL                 C           REFS         45      3*226
   1074  WT11       REAL                 C           REFS         22        214
   1076  WT12       REAL                 C           REFS         24        212
   1075  WTR1       REAL                 C           REFS         23        215
   1077  WTR2       REAL                 C           REFS         25        213
    715  W1Q        REAL                             REFS        223     DEFINED       222
    746  XL         REAL          ARRAY              REFS         83        195        197

FILE NAMES          MODE
      TAPE6         FMT                 WRITES       206        238

EXTERNALS           TYPE    ARGS        REFERENCES
      ATAND         REAL      2            168       169        191        192
      COSD          REAL      1            134       136
      FINTP1        REAL      6            196       197
      SIND          REAL      1            135       137

INLINE FUNCTIONS    TYPE    ARGS        DEF LINE  REFERENCES
      ABS           REAL      1   INTRIN             2*198       205        217        218        232        233      2*246      2*247
                                                       265       266        274        281      2*284        290        298      2*301
      AINT          REAL      1   INTRIN               130
      SIGN          REAL      2   INTRIN               217       218        265        266        275        281        282        291
                                                       298       299

STATEMENT LABELS              DEF LINE   REFERENCES
     10  1                       131        128
      0  2                       178        174
      0  3        INACTIVE       308
    135  4                       179        172
    114  5                       184        192
    325  20                      243        237
    342  21                      248        242
    216  30                      209        189       198        200
    141  32                      193        167
    435  70                      279        274
    467  73                      288        270
    504  80                      295        290
    541  83                      305        294
    632  100     FMT             239        238
    613  101     FMT             207        206

LOOPS  LABEL    INDEX      FROM-TO      LENGTH     PROPERTIES
  132  2        L          174 178        38B      INSTACK
```

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      SUBROUTINE S2          74/74    OPT=1                       FTN 4.2+74355        07/07/75  11.07.46.        PAGE    12

  COMMON BLOCKS    LENGTH       MEMBERS - BIAS NAME(LENGTH)
        C             3830                 0 C          (3830)

  EQUIV CLASSES    LENGTH       MEMBERS - BIAS NAME(LENGTH)
  C       C           3830           370 RANGE    (1)           371 RXBA     (1)           372 RYBA     (1)
                                     373 RZBA     (1)           402 WLAMQ    (1)           406 WLAMR    (1)
                                     423 BTHTGD   (1)           426 BTHTG    (1)           427 BPSIGD   (1)
                                     430 BPSIG    (1)           434 BEPSZ    (1)           435 BEPSY    (1)
                                     479 GQ1      (1)           480 GR1      (1)           481 GQ2      (1)
                                     482 GR2      (1)           483 GQ3      (1)           484 GR3      (1)
                                     485 GQ4      (1)           486 GR4      (1)           488 GQ5      (1)
                                     489 GR5      (1)           490 GQ6      (1)           491 GR6      (1)
                                     492 DTHCQ    (1)           493 DTHCR    (1)           494 DTHRGQ   (1)
                                     495 DTHRGR   (1)           496 GEOCS    (1)           499 DQ1      (1)
                                     500 DR1      (1)           502 Q1       (1)           503 R1       (1)
                                     505 DQ2      (1)           506 DR2      (1)           508 Q2       (1)
                                     509 R2       (1)           511 DQ3      (1)           512 DR3      (1)
                                     513 DWO      (1)           514 Q3       (1)           515 R3       (1)
                                     516 WO       (1)           517 DDQ4     (1)           518 DDR4     (1)
                                     519 DWI      (1)           520 DQ4      (1)           521 DR4      (1)
                                     522 WI       (1)           523 Q4       (1)           524 R4       (1)
                                     525 BEPSYSV  (1)           526 DDQ5     (1)           527 DDR5     (1)
                                     528 BEPSZSV  (1)           529 DQ5      (1)           530 DR5      (1)
                                     532 Q5       (1)           533 R5       (1)           535 DDQ6     (1)
                                     536 DDR6     (1)           538 DQ6      (1)           539 DR6      (1)
                                     541 Q6       (1)           542 R6       (1)           544 KQ1      (1)
                                     545 KR1      (1)           546 KQ2      (1)           547 KR2      (1)
                                     548 KQ3      (1)           549 KR3      (1)           550 KQ5      (1)
                                     551 KR5      (1)           552 KQ6      (1)           553 KR6      (1)
                                     554 KQ7      (1)           555 KR7      (1)           556 KQ8      (1)
                                     557 KR8      (1)           558 KQ10     (1)           559 KR10     (1)
                                     560 KQ11     (1)           561 KR11     (1)           562 KQ12     (1)
                                     563 KR12     (1)           564 JI       (1)           565 JO       (1)
                                     566 FRI      (1)           567 FRO      (1)           568 TUI      (1)
                                     569 TJO      (1)           570 QERG     (1)           571 RERG     (1)
                                     572 WTQ1     (1)           573 WTR1     (1)           574 WTQ2     (1)
                                     575 WTR2     (1)           576 WGQ1     (1)           577 WGR1     (1)
                                     578 WGQ2     (1)           579 WGR2     (1)           580 WGQ3     (1)
                                     581 WGR3     (1)           582 WGQ4     (1)           583 WGR4     (1)
                                     584 WGQ5     (1)           585 WGR5     (1)           586 WGQ6     (1)
                                     587 WGR6     (1)           588 WRQ1     (1)           589 WRR1     (1)
                                     590 WRQ2     (1)           591 WRR2     (1)           592 WRQ3     (1)
                                     593 WRR3     (1)           594 WRQ4     (1)           595 WRR4     (1)
                                     596 ROL      (1)           597 TOLQ     (1)           598 TOLR     (1)
                                     599 TAU      (1)           600 TARHT    (1)           601 TARWD    (1)
                                     602 RBLOCK   (1)           603 FFOV     (1)           604 IOCS     (1)
                                     605 TLAG     (1)           606 BRLKQ    (1)           607 TDELAY   (1)
                                     608 THTQ     (1)           609 THTR     (1)           610 KUO      (1)
                                     611 KJI      (1)           612 KBO      (1)           613 KBI      (1)
                                     614 KPO      (1)           615 KPI      (1)           616 KOAO     (1)
                                     617 KOAI     (1)           618 UCC      (1)           619 USC      (1)
                                     620 UGGG     (1)           621 USGG     (1)           624 IBL      (1)
                                     649 TIMESV   (6)           655 LOSZ     (6)           661 LOSY     (6)
                                    1675 ANGX     (1)          1676 ANGY     (1)          1677 ANGZ     (1)
                                    1735 WPD      (1)          1738 WP       (1)          1739 WQD      (1)
                                    1742 WQ       (1)          1743 WRD      (1)          1746 WR       (1)
                                    1750 CRAD     (1)          1999 TIME     (1)          2019 LCONV    (1)
                                    3511 I3512    (1)          3633 ISNOK    (1)
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STATISTICS
  PROGRAM LENGTH                  7908      488
  CM LABELED COMMON LENGTH       73663     3830
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      SUBROUTINE S3                                                     S3         2
C                                                                       S3         3
C ** OLS SEEKER MODULE**                                                S3         4
C                                                                       S3         5
C**LOW FREQUENCE SEEKER                                                 S3         6
C                                                                       S3         7
      COMMON /C/ C(3830)                                                LABC04    55
      REAL KQ1,KQ2,KQ3,KQ4,KQ5,KQ6,KQ7,KQ8,KQ9,KQ10,KQ11,KQ12           S3         9
      REAL KR1,KR2,KR3,KR4,KR5,KR6,KR7,KR8,KR9,KR10,KR11,KR12           S3        10
      REAL KUO,KUI,KBO,KBI,KPO,KPI,KOAO,KOAI                            S3        11
      REAL JI,JO                                                        S3        12
C**INPUT DATA                                                           S3        13
      EQUIVALENCE (C( 545),    KQ1),  (C( 573),   WTQ1)                 S3        14
      EQUIVALENCE (C( 546),    KR1),  (C( 574),   WTR1)                 S3        15
      EQUIVALENCE (C( 547),    KQ2),  (C( 575),   WTQ2)                 S3        16
      EQUIVALENCE (C( 548),    KR2),  (C( 576),   WTR2)                 S3        17
      EQUIVALENCE (C( 549),    KQ3),  (C( 577),   WGQ1)                 S3        18
      EQUIVALENCE (C( 550),    KR3),  (C( 578),   WGR1)                 S3        19
      EQUIVALENCE (C( 551),    KQ5),  (C( 579),   WGQ2)                 S3        20
      EQUIVALENCE (C( 552),    KR5),  (C( 580),   WGR2)                 S3        21
      EQUIVALENCE (C( 553),    KQ6),  (C( 581),   WGQ3)                 S3        22
      EQUIVALENCE (C( 554),    KR6),  (C( 582),   WGR3)                 S3        23
      EQUIVALENCE (C( 555),    KQ7),  (C( 583),   WGQ4)                 S3        24
      EQUIVALENCE (C( 556),    KR7),  (C( 584),   WGR4)                 S3        25
      EQUIVALENCE (C( 557),    KQ8),  (C( 585),   WGQ5)                 S3        26
      EQUIVALENCE (C( 558),    KR8),  (C( 586),   WGR5)                 S3        27
      EQUIVALENCE (C( 559),   KQ10),  (C( 587),   WGQ5)                 S3        28
      EQUIVALENCE (C( 560),   KR10),  (C( 588),   WGR6)                 S3        29
      EQUIVALENCE (C( 561),   KQ11),  (C( 589),   WRQ1)                 S3        30
      EQUIVALENCE (C( 562),   KR11),  (C( 590),   WRR1)                 S3        31
      EQUIVALENCE (C( 563),   KQ12),  (C( 591),   WRQ2)                 S3        32
      EQUIVALENCE (C( 564),   KR12),  (C( 592),   WRR2)                 S3        33
      EQUIVALENCE (C( 565),     JI),  (C( 593),   WRQ3)                 S3        34
      EQUIVALENCE (C( 566),     JO),  (C( 594),   WRR3)                 S3        35
      EQUIVALENCE (C( 567),    FRI),  (C( 595),   WRQ4)                 S3        36
      EQUIVALENCE (C( 568),    FRO),  (C( 596),   WRR4)                 S3        37
      EQUIVALENCE (C( 569),    TUI),  (C( 597),    RCL)                 S3        38
      EQUIVALENCE (C( 570),    TUO),  (C( 598),   TCLQ)                 S3        39
      EQUIVALENCE (C( 571),   QERG),  (C( 599),   TCLR)                 S3        40
      EQUIVALENCE (C( 572),   RERG),  (C( 600),    TAU)                 S3        41
      EQUIVALENCE (C( 480),    GQ1),  (C( 482),    GQ2)                 S3        42
      EQUIVALENCE (C( 481),    GR1),  (C( 483),    GR2)                 S3        43
      EQUIVALENCE (C( 484),    GQ3),  (C( 486),    GQ4)                 S3        44
      EQUIVALENCE (C( 485),    GR3),  (C( 487),    GR4)                 S3        45
      EQUIVALENCE (C( 489),    GQ5),  (C( 491),    GQ6)                 S3        46
      EQUIVALENCE (C( 490),    GR5),  (C( 492),    GR6)                 S3        47
      EQUIVALENCE (C( 601),  TARHT),  (C( 602),  TARHD)                 S3        48
      EQUIVALENCE (C( 608), TDELAY),  (C( 609),   THTQ), (C( 610), THTR) S3       49
      EQUIVALENCE (C( 604),   FFOV)                                     S3        50
      EQUIVALENCE (C( 603), RBLOCK),  (C( 605),   IOCS)                 S3        51
      EQUIVALENCE (C( 497),  GEOCS)                                     S3        52
      EQUIVALENCE (C( 606),   TLAG)                                     S3        53
C                                                                       S3        54
C**INPUTS FROM OTHER MODULES**                                          S3        55
      EQUIVALENCE (C( 372),   RXBA)                                     S3        56
      EQUIVALENCE (C( 373),   RYBA)                                     S3        57
      EQUIVALENCE (C( 374),   RZBA)                                     S3        58
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      EQUIVALENCE (C(1739),     WP)
      EQUIVALENCE (C(1743),     WQ)
      EQUIVALENCE (C(1747),     WR)
      EQUIVALENCE (C(1751),   CRAD)
      EQUIVALENCE (C(2000),   TIME)
      EQUIVALENCE (C( 371),  RANGE)
      EQUIVALENCE (C(1676),   ANGX)
      EQUIVALENCE (C(1677),   ANGY)
      EQUIVALENCE (C(1678),   ANGZ)
      EQUIVALENCE (C(1736),    WPD)
      EQUIVALENCE (C(1740),    WQD)
      EQUIVALENCE (C(1744),    WRD)
      EQUIVALENCE (C( 550),TIMESV)
      EQUIVALENCE (C( 656),  LOSZ)
      EQUIVALENCE (C( 662),  LOSY)
      REAL LOSZ,LOSY
      DIMENSION TIMESV(6),LOSZ(6),LOSY(6),XL(2)
C
C**STATE VARIABLES
      EQUIVALENCE (C( 424), BTHTGD),  (C( 427),  BTHTG)
      EQUIVALENCE (C( 428), BPSIGD),  (C( 431),  BPSIG)
      EQUIVALENCE (C( 500),    DQ1),  (C( 503),     Q1)
      EQUIVALENCE (C( 501),    DR1),  (C( 504),     R1)
      EQUIVALENCE (C( 506),    DQ2),  (C( 509),     Q2)
      EQUIVALENCE (C( 507),    DR2),  (C( 510),     R2)
      EQUIVALENCE (C( 512),    DQ3),  (C( 515),     Q3)
      EQUIVALENCE (C( 513),    DR3),  (C( 516),     R3)
      EQUIVALENCE (C( 514),    DWD),  (C( 517),     WD)
      EQUIVALENCE (C( 520),    DWI),  (C( 523),     WI)
C
C**OTHER OUTPUTS
      EQUIVALENCE (C( 435),  BEPSZ)
      EQUIVALENCE (C( 436),  BEPSY)
      EQUIVALENCE (C( 403),  WLAMQ)
      EQUIVALENCE (C( 407),  WLAMR)
      EQUIVALENCE (C( 526),BEPSYSV)
      EQUIVALENCE (C( 529),BEPSZSV)
      EQUIVALENCE (C( 493),  DTHCQ),  (C( 494),  DTHCR)
      EQUIVALENCE (C( 495), DTHRGQ),  (C( 496), DTHRGR)
      EQUIVALENCE (C(2020),  LCONV),  (C( 625),    IBL)
      EQUIVALENCE (C( 607), BRLKQ)
C
C**MONTE CARLO PARAMETERS
C
      EQUIVALENCE (C(3634),  ISNOX),  (C(3512),  I3512)
      EQUIVALENCE (C( 611),    KUD),  (C( 612),    KUI)
      EQUIVALENCE (C( 613),    KBD),  (C( 614),    KBI)
      EQUIVALENCE (C( 615),    KPD),  (C( 616),    KPI)
      EQUIVALENCE (C( 617),    KOAD), (C( 618),   KOAI)
      EQUIVALENCE (C( 619),    UCC),  (C( 620),    USC)
      EQUIVALENCE (C( 621),   UCCG),  (C( 622),   USCG)
      DATA FOV/4./
C
C INTEGRATION SWITCHING TEST
C           SYNCHRONIZE INTEGRATION WITH SAMPLE SIZE
      IF(C(13).LE.0.)GO TO 1
      C(13)=-1.
```

SUBROUTINE S3   74/74   OPT=1   FTN 4.2+74355   07/07/75   11.08.03.   PAGE   3

```
          C(2584)=TAU/AINT(TAU/C(2784))                          S3    116
    1     CONTINUE                                               S3    117
    C                                                            S3    118
    C**DIRECTION COSINES FOR BODY TO PLATFORM TRANSFORMATION     S3    119
          UCT=COSD(BTHTG)                                        S3    120
          UST=SIND(BTHTG)                                        S3    121
          UCP=COSD(BPSIG)                                        S3    122
          USP=SIND(BPSIG)                                        S3    123
          UB11=UCT*UCP                                           S3    124
          UB12=USP                                               S3    125
          UB13=-UCP*UST                                          S3    126
          UB21=-UCT*USP                                          S3    127
          UB22=UCP                                               S3    128
          UB23=UST*USP                                           S3    129
          UB31=UST                                               S3    130
          UB32=0.                                                S3    131
          UB33=UCT                                               S3    132
    C                                                            S3    133
    C**TRANSFORM LOS FROM BODY TO GIMBAL AXES                    S3    134
          RXG=UB11*RXBA+UB12*RYBA+UB13*RZBA                      S3    135
          RYG=UB21*RXBA+UB22*RYBA+UB23*RZBA                      S3    136
          RZG=UB31*RXBA+UB32*RYBA+UB33*RZBA                      S3    137
          IF(I3512.LE.0)GO TO 5                                  S3    138
    C**GYRO ERRORS                                               S3    139
    C                                                            S3    140
    C**TRANSFORM NORMALIZED ACCELERATIONS FROM BODY TO GIMBAL AXES   S3    141
          ANGXG=UB11*ANGX+UB12*ANGY+UB13*ANGZ                    S3    142
          ANGYG=UB21*ANGX+UB22*ANGY+UB23*ANGZ                    S3    143
          ANGZG=UB31*ANGX+UB32*ANGY+UB33*ANGZ                    S3    144
          ANG=ANGZG*UCCG-ANGYG*USCG                              S3    145
          QERG=KBO+KPO*ANG+KOAO*WPO                              S3    146
          RERG=KBI+KPI*ANG+KOAI*WPO                              S3    147
          TUO=KUU*(ANGX*UCT-ANGZ*UST)                            S3    148
          TUI=KUI*(ANGYG*UCC-ANGXG*USC)                          S3    149
    5     CONTINUE                                               S3    150
    C                                                            S3    151
    C**LOS ERRORS IN PLATFORM COORDINATES                        S3    152
          IF(C(1976).LE.0.)GO TO 32                              S3    153
          BEPSZ=ATAND(-RZG,RXG)                                  S3    154
          BEPSY=ATAND( RYG,RXG)                                  S3    155
    C****SAVE THE PREVIOUS FIVE POINTS IN TIME OF BEPSZ AND BEPSY FOR TLAG.   S3    156
          DO 2 L=2,6                                             S3    157
          TIMESV(L-1)=TIMESV(L)                                  S3    158
          LOSZ(L-1)=LOSZ(L)                                      S3    159
          LOSY(L-1)=LOSY(L)                                      S3    160
    2     CONTINUE                                               S3    161
          TIMESV(6)=TIME                                         S3    162
          LOSZ(6)=BEPSZ                                          S3    163
          LOSY(6)=BEPSY                                          S3    164
    32    CONTINUE                                               S3    165
    C                                                            S3    166
    C         TRACKER LOOP                                       S3    167
    C                                                            S3    168
    C                                                            S3    169
    C**ZOH (TDELAY..TAU) AND TIME DELAY (TLAG)                   S3    170
          IF(TIME.LT.(TDELAY-.00001).OR.C(1976).LE.0.)GO TO 30   S3    171
          TDELAY=TIME+TAU                                        S3    172
```

```
      THT2=ATAND(TARHT/2.,RANGE)
      THTR=ATAND(TARWD/2.,RANGE)
      BRLKQ=(BEPSZ-BEPSZSV)/(2.*THTQ)
      BRLKR=(BEPSY-BEPSYSV)/(2.*THTR)
      TTLAG=TIME-TLAG    $  N=6   $  F=0.
      BEPSZSV=FINTP1(     TTLAG,TIMESV,LOSZ,N,F,XL)
      BEPSYSV=FINTP1(     TTLAG,TIMESV,LOSY,N,F,XL)
      IF(ABS(BRLKQ) .LT. .5 .AND. ABS(BRLKR) .LT. .5)GO TO 30
C**BREAKLOCK DETERMINATION
      IF(IOCS.NE.-10)GO TO 30
      IBL=IBL+1
      LCONV=2
      IOCS=-9
      WHICH = 10H IN PITCH
      IF(ABS(BRLKR) .GE. .5)WHICH = 10H IN YAW
      WRITE(6,101)TIME,RANGE,WHICH
  101 FORMAT(1H0,100(1H*)/* BREAK LOCK CONDITION AT TIME= *F5.2,
     + * RANGE = *F10.2,A10,/100(1H*))
   30 CONTINUE
      DELAYQ=GQ1*BEPSZSV
      DELAYR=GR1*BEPSYSV
      DQ1=     DELAYQ-WTQ2*Q1
      DR1=     DELAYR-WTR2*R1
      DTHCQ=(DQ1+WTQ1*Q1)*GQ2
      DTHCR=(DR1+WTR1*R1)*GR2
C       RATE COMMAND LIMIT
      IF(ABS(DTHCQ).GT.RCL)DTHCQ=SIGN(RCL,DTHCQ)
      IF(ABS(DTHCR).GT.RCL)DTHCR=SIGN(RCL,DTHCR)
C
C       RATE GYRO LOOP
C
      W1Q=WO*UCP-(WP*UST-WR*UST)*USP
      RGQ=GQ5*(W1Q+QERG)
      RGR=GR5*(WI +RERG)
      DTHRGQ=KQ12*RGQ
      DTHRGR=KR12*RGR
C
C**BLIND RANGE DETERMINATION
      THTOAQ=THTQ+ABS(BEPSZ)
      THTOAR=THTR+ABS(BEPSY)
      BLNDQ=THTOAQ*2./FOV
      BLNDR=THTOAR*2./FOV
      TESTFOV=FFOV*FOV/2.
      IF(THTOAQ.LT.TESTFOV.AND.THTOAR.LT.TESTFOV) GO TO 20
      IF(IOCS.LE.0)WRITE(6,100)TIME,RANGE
  100 FORMAT(1H0,100(1H*)/* OCS BLIND RANGE SIGNAL HOLD AT TIME = *F5.2,
     + *  RANGE = *F10.2/100(1H*))
      IOCS=10
      GO TO 21
   20 CONTINUE
C
C**OUTPUT TO AUTOPILOT
      WLAMQ=GEOCS*RGQ
      WLAMR=GEOCS*RGR
      IF(ABS(C(630)).LT.ABS(BRLKQ))C(630)=BRLKQ
      IF(ABS(C(631)).LT.ABS(BRLKR))C(631)=BRLKR
   21 CONTINUE
```

```
      C
      C       GAIN COMPENSATION
      C
            DTHTEQ=DTHCQ-DTHRGQ
            DTHTER=DTHCR-DTHRGR
            DQ2=     DTHTEQ
            DR2=     DTHTER
            DQ3=DQ2+WGQ1*Q2-WGQ4*Q3
            DR3=DR2+WGR1*R2-WGR4*R3
      C
      C       SEEKER TORQUE MOTOR
      C
            TQ=GQ3*(DQ3+WGQ3*Q3)
            TR=GR3*(DR3+WGR3*R3)
            IF(ABS(TQ).GT.TCLQ)TQ=SIGN(TCLQ,TQ)
            IF(ABS(TR).GT.TCLR)TR=SIGN(TCLR,TR)
            TMQ=GQ4*TQ
            TMR=GR4*TR
      C
      C       SEEKER GIMBAL ANGLE RATES
      C
      C**COULOMB FRICTION MODEL
            TCOMQ=KQ8*BTHTG/CRAD
            IF(ABS(BTHTGD).LE.4.E-4)GO TO 70
            TFQ=             SIGN(FRO,BTHTGD)
            TAQ=TMQ-TFQ-TCOMQ-TUO
            DWO=TAQ*CRAD/JO
            GO TO 73
   70       CONTINUE
            TFQ=TMQ-TCOMQ-TUO
            IF(ABS(TFQ).GT.FRO)TFQ=SIGN(FRO,TMQ)
            WCOQ=(TFQ+SIGN(FRO,WQD))*CRAD/JO
            DWBAQ=WQD
            IF(ABS(WQD).GT.ABS(WCOQ))DWBAQ=WCOQ
            TAQ=TMQ-TFQ-TCOMQ-TUO
            DWAQ=TAQ/JO*CRAD
            DWO=DWBAQ+DWAQ
   73       CONTINUE
            TCOMR=KR8*BPSIG/CRAD
            IF(ABS(BPSIGD).LE.4.E-4)GO TO 80
            TFR=SIGN(FRI,BPSIGD)
            TAR=TMR-TFR-TCOMR-TUI
            DWI=TAR*CRAD/JI
            GO TO 83
   80       CONTINUE
            WRES=UCT*WRD+UST*WPD
            TFR=TMR-TCOMR-TUI
            IF(ABS(TFR).GT.FRI)TFR=SIGN(FRI,TMR)
            WCOR=(TFR+SIGN(FRI,WRES))*CRAD/JI
            DWBAR=WRES
            IF(ABS(WRES).GT.ABS(WCOR))DWBAR=WCOR
            TAR=TMR-TFR-TCOMR-TUI
            DWAR=TAR/JI*CRAD
            DWI=DWBAR+DWAR
   83       CONTINUE
            BTHTGD=WO-WQ
            BPSIGD=WI-(WR*UCT+WP*UST)
```

```
     3    CONTINUE                                              S3        287
          RETURN                                                S3        288
          END                                                   S3        289
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SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS     DEF LINE     REFERENCES
   1  S3              1        287

VARIABLES       SN  TYPE              RELOCATION
   637  ANS          REAL                         REFS       145      146  DEFINED      144
  3213  ANSX         REAL                  C      REFS        64      141      142      143      147
   634  ANSXG        REAL                         REFS       148  DEFINED      141
  3214  ANSY         REAL                  C      REFS        65      141      142      143
   635  ANSYG        REAL                         REFS       144      149  DEFINED      142
  3215  ANSZ         REAL                  C      REFS        66      141      142      143      147
   636  ANSZG        REAL                         REFS       144  DEFINED      143
   663  BEPSY        REAL                  C      REFS        90      163      175      211  DEFINED      154
  1015  BEPSYSV      REAL                  C      REFS        93      173      192  DEFINED      178
   662  BEPSZ        REAL                  C      REFS        89      162      174      210  DEFINED      153
  1020  BEPSZSV      REAL                  C      REFS        94      174      191  DEFINED      177
   655  BLNDQ      * REAL                      DEFINED       212
   656  BLNDR      * REAL                      DEFINED       213
   656  BPSIG        REAL                  C      REFS        78      121      122      267
   653  BPSIGD       REAL                  C      REFS        78      268      269  DEFINED      285
  1136  BRLKQ        REAL                  C      REFS        98      179    2*226  DEFINED      174
   641  BRLKR        REAL                         REFS       179      185    2*227  DEFINED      175
   652  BTHTG        REAL                  C      REFS        77      119      120      251
   647  BTHTGD       REAL                  C      REFS        77      252      253  DEFINED      284
     0  C            REAL         ARRAY    C      REFS         7     2*13     2*14     2*15     2*16     2*17     2*18
                                                  2*19      2*20     2*21     2*22     2*23     2*24     2*25     2*26
                                                  2*27      2*28     2*29     2*30     2*31     2*32     2*33     2*34
                                                  2*35      2*36     2*37     2*38     2*39     2*40     2*41     2*42
                                                  2*43      2*44     2*45     2*46     2*47     3*48       49     2*50
                                                    51        52       55       56       57       58       59       60
                                                    61        62       63       64       65       66       67       68
                                                    69        70       71       72     2*77     2*78     2*79     2*80
                                                  2*81      2*82     2*83     2*84     2*85     2*86       89       90
                                                    91        92       93       94     2*95     2*96     2*97       98
                                                 2*102     2*103    2*104    2*105    2*106    2*107    2*108      113
                                                   115       152      170      226      227  DEFINED      114      115
                                                   226       227
  3326  CRAD         REAL                  C      REFS        61      251      255      260      264      267      271
                                                   277       281
   646  DELAYQ       REAL                         REFS       193  DEFINED      191
   647  DELAYR       REAL                         REFS       194  DEFINED      192
   763  DQ1          REAL                  C      REFS        79      195  DEFINED      193
   771  DQ2          REAL                  C      REFS        81      235  DEFINED      234
   777  DQ3          REAL                  C      REFS        83      241  DEFINED      236
   764  DR1          REAL                  C      REFS        80      196  DEFINED      194
   772  DR2          REAL                  C      REFS        82      237  DEFINED      235
  1000  DR3          REAL                  C      REFS        84      242  DEFINED      237
   754  DTHGQ        REAL                  C      REFS        95    2*198      232  DEFINED      195      198
   755  DTHGR        REAL                  C      REFS        95    2*199      233  DEFINED      196      199
   756  DTHRGQ       REAL                  C      REFS        95      232  DEFINED      206
   757  DTHRGR       REAL                  C      REFS        96      233  DEFINED      207
   660  DTHTEQ       REAL                         REFS       234  DEFINED      232
   661  DTHTER       REAL                         REFS       235  DEFINED      233
   673  DWAQ         REAL                         REFS       265  DEFINED      264
   702  DWAR         REAL                         REFS       282  DEFINED      281
   672  DWBAQ        REAL                         REFS       265  DEFINED      261      262
```

VARIABLES		SN	TYPE	RELOCATION								
701	DW3AR		REAL			REFS	282	DEFINED	278	279		
1007	DWI		REAL		C	REFS	86	DEFINED	271	282		
1001	DWO		REAL		C	REFS	85	DEFINED	255	265		
644	F		REAL			REFS	177	178	DEFINED	176		
1133	FFOV		REAL		C	REFS	49	214				
540	FOV		REAL			REFS	212	213	214	DEFINED	189	
1066	FRI		REAL		C	REFS	35	269	2*276	277		
1067	FRO		REAL		C	REFS	36	253	2*259	268		
760	GEOCS		REAL		C	REFS	51	224	225			
737	GQ1		REAL		C	REFS	41	191				
741	GQ2		REAL		C	REFS	41	193				
743	GQ3		REAL		C	REFS	43	241				
745	GQ4		REAL		C	REFS	43	245				
750	GQ5		REAL		C	REFS	45	204				
752	GQ6		REAL		C	REFS	45					
740	GR1		REAL		C	REFS	42	192				
742	GR2		REAL		C	REFS	42	196				
744	GR3		REAL		C	REFS	44	242				
746	GR4		REAL		C	REFS	44	246				
751	GR5		REAL		C	REFS	46	205				
753	GR6		REAL		C	REFS	46					
1160	I3L		INTEGER		C	REFS	97	182	DEFINED	182		
1134	IOCS		INTEGER		C	REFS	50	181	218	DEFINED	184	219
7061	ISNDX		INTEGER		C	REFS	102					
3667	I3512		INTEGER		C	REFS	102	187				
1064	JI		REAL		C	REFS	11	33	271	277	281	
1065	JO		REAL		C	REFS	11	34	255	260	264	
1145	KBI		REAL		C	REFS	10	104	146			
1144	KBO		REAL		C	REFS	10	104	145			
1151	KOAI		REAL		C	REFS	10	106	146			
1150	KOAO		REAL		C	REFS	10	105	145			
1147	KPI		REAL		C	REFS	10	105	146			
1146	KPO		REAL		C	REFS	10	105	145			
1040	KQ1		REAL		C	REFS	8	13				
1056	KQ10		REAL		C	REFS	8	27				
1060	KQ11		REAL		C	REFS	8	29				
1062	KQ12		REAL		C	REFS	8	31	206			
1042	KQ2		REAL		C	REFS	8	15				
1044	KQ3		REAL		C	REFS	8	17				
610	KQ4	*	REAL	*UNDEF		REFS	8					
1046	KQ5		REAL		C	REFS	8	19				
1050	KQ6		REAL		C	REFS	8	21				
1052	KQ7		REAL		C	REFS	8	23				
1054	KQ8		REAL		C	REFS	8	25	251			
611	KQ9	*	REAL	*UNDEF		REFS	8					
1041	KR1		REAL		C	REFS	9	14				
1057	KR10		REAL		C	REFS	9	28				
1061	KR11		REAL		C	REFS	9	30				
1063	KR12		REAL		C	REFS	9	32	207			
1043	KR2		REAL		C	REFS	9	16				
1045	KR3		REAL		C	REFS	9	18				
612	KR4	*	REAL	*UNDEF		REFS	9					
1047	KR5		REAL		C	REFS	9	20				
1051	KR6		REAL		C	REFS	9	22				
1053	KR7		REAL		C	REFS	9	24				
1055	KR8		REAL		C	REFS	9	25	267			
613	KR9	*	REAL	*UNDEF		REFS	9					

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VARIABLES      SN  TYPE          RELOCATION
  1143  KUI        REAL                C       REFS        10      103      148
  1142  KUO        REAL                C       REFS        10      103      147
   640  L          INTEGER                     REFS     2*157    2*158    2*159   DEFINED      156
  3743  LCONV      INTEGER             C       REFS        97  DEFINED      183
  1225  LOSY       REAL       ARRAY    C       REFS        72       73       74       159      178
                                            DEFINED       159      163
  1217  LOSZ       REAL       ARRAY    C       REFS        71       70       74       158      177
                                            DEFINED       158      162
   643  N          INTEGER                     REFS       177      179  DEFINED       176
  1072  QERG       REAL                C       REFS        39      204  DEFINED       145
   766  Q1         REAL                C       REFS        79      193      195
   774  Q2         REAL                C       REFS        81      235
  1002  Q3         REAL                C       REFS        83      235      241
   562  RANGE      REAL                C       REFS        63      172      173       187      216
  1132  RBLOCK     REAL                C       REFS        50
  1124  RGL        REAL                C       REFS        37    2*198    2*199
  1073  RERG       REAL                C       REFS        40      205  DEFINED       146
   651  RGQ        REAL                        REFS       206      224  DEFINED       204
   652  RGR        REAL                        REFS       207      225  DEFINED       205
   563  RX3A       REAL                C       REFS        55      134      135       136
   631  RXS        REAL                        REFS       153      154  DEFINED       134
   564  RY3A       REAL                C       REFS        56      134      135       136
   632  RYS        REAL                        REFS       154  DEFINED      135
   565  RZ3A       REAL                C       REFS        57      134      135       136
   633  RZS        REAL                        REFS       153  DEFINED      136
   767  R1         REAL                C       REFS        80      194      196
   775  R2         REAL                C       REFS        82      287
  1003  R3         REAL                C       REFS        84      287      242
   670  TAQ        REAL                        REFS       255      264  DEFINED       254      263
   676  TAR        REAL                        REFS       271      281  DEFINED       270      280
  1130  TARMT      REAL                C       REFS        47      172
  1131  TARWD      REAL                C       REFS        47      173
  1127  TAJ        REAL                C       REFS        40    2*115      171
  1125  TCLQ       REAL                C       REFS        38    2*243
  1126  TCLR       REAL                C       REFS        39    2*244
   666  TCOMQ      REAL                        REFS       254      258      263   DEFINED      251
   674  TCOMR      REAL                        REFS       270      275      280   DEFINED      267
  1137  TDELAY     REAL                C       REFS        48      170  DEFINED       171
   657  TESTFOV    REAL                        REFS     2*215  DEFINED      214
   667  TFQ        REAL                        REFS       254      259      260       263  DEFINED   253   258
                                                259
   675  TFR        REAL                        REFS       270      275      277       280  DEFINED   269   275
                                                276
   653  THTOAQ     REAL                        REFS       212      215  DEFINED       218
   654  THTOAR     REAL                        REFS       213      215  DEFINED       211
  1140  THTQ       REAL                C       REFS        48      174      210   DEFINED      172
  1141  THTR       REAL                C       REFS        48      175      211   DEFINED      173
  3717  TIME       REAL                C       REFS        62      161      170       171      176   187   216
  1211  TIMESV     REAL       ARRAY    C       REFS        70       74      157       177      178
                                            DEFINED       157      161
  1135  TLAG       REAL                C       REFS        52      176
   664  TMQ        REAL                        REFS       254      258      259       263  DEFINED   245
   665  TMR        REAL                        REFS       270      275      276       280  DEFINED   246
   662  TQ         REAL                        REFS     2*243      245  DEFINED       241      243
   663  TR         REAL                        REFS     2*244      246  DEFINED       242      244
   642  TTLAG      REAL                        REFS       177      178  DEFINED       176
  1070  TUI        REAL                C       REFS        37      270      275       280  DEFINED   148
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VARIABLES     SN  TYPE            RELOCATION
  1071  TUO        REAL             C         REFS       38      254      258      263    DEFINED     247
   620  UB11       REAL                       REFS      134      141   DEFINED     123
   621  UB12       REAL                       REFS      134      141   DEFINED     124
   622  UB13       REAL                       REFS      134      141   DEFINED     125
   623  UB21       REAL                       REFS      135      142   DEFINED     126
   624  UB22       REAL                       REFS      135      142   DEFINED     127
   625  UB23       REAL                       REFS      135      142   DEFINED     128
   626  UB31       REAL                       REFS      136      143   DEFINED     129
   627  UB32       REAL                       REFS      136      143   DEFINED     130
   630  UB33       REAL                       REFS      136      143   DEFINED     131
  1152  UCO        REAL             C         REFS      107      149
  1154  UCOG       REAL             C         REFS      108      144
   616  UCP        REAL                       REFS      123      125      127      203    DEFINED     121
   614  UCT        REAL                       REFS      123      125      131      147      203      274      285
                                           DEFINED      119
  1153  USO        REAL             C         REFS      107      148
  1155  USOG       REAL             C         REFS      108      144
   617  USP        REAL                       REFS      124      125      128      203    DEFINED     122
   615  UST        REAL                       REFS      125      129      129      147      203      274      285
                                           DEFINED      120
   671  WC0Q       REAL                       REFS    2*262   DEFINED     260
   700  WCOR       REAL                       REFS    2*279   DEFINED     277
  1100  WGQ1       REAL             C         REFS       17      235
  1102  WGQ2       REAL             C         REFS       19
  1104  WGQ3       REAL             C         REFS       21      241
  1106  WGQ4       REAL             C         REFS       23      235
  1110  WGQ5       REAL             C         REFS       25
  1112  WGQ6       REAL             C         REFS       27
  1101  WGR1       REAL             C         REFS       18      237
  1103  WGR2       REAL             C         REFS       20
  1105  WGR3       REAL             C         REFS       22      242
  1107  WGR4       REAL             C         REFS       24      237
  1111  WGR5       REAL             C         REFS       26
  1113  WGR6       REAL             C         REFS       28
   645  WHICH      REAL                       REFS      187   DEFINED     185      186
  1012  WI         REAL             C         REFS       85      205      285
   622  WLAMQ      REAL             C         REFS       91   DEFINED     224
   626  WLAMR      REAL             C         REFS       92   DEFINED     225
  1004  WO         REAL             C         REFS       85      203      284
  3312  WP         REAL             C         REFS       58      203      235
  3307  WPO        REAL             C         REFS       67      145      146      274
  3316  WQ         REAL             C         REFS       59      204
  3313  WQO        REAL             C         REFS       68      260      261      262
  3322  WR         REAL             C         REFS       60      203      285
  3317  WRO        REAL             C         REFS       69      274
   677  WRES       REAL                       REFS      277      278      279    DEFINED     274
  1114  WRQ1       REAL             C         REFS       29
  1116  WRQ2       REAL             C         REFS       31
  1120  WRQ3       REAL             C         REFS       33
  1122  WRQ4       REAL             C         REFS       35
  1115  WRR1       REAL             C         REFS       30
  1117  WRR2       REAL             C         REFS       32
  1121  WRR3       REAL             C         REFS       34
  1123  WRR4       REAL             C         REFS       36
  1074  WTQ1       REAL             C         REFS       13      195
  1076  WTQ2       REAL             C         REFS       15      193
  1075  WTR1       REAL             C         REFS       14      196
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       SUBROUTINE S3          74/74    OPT=1                    FTN 4.2+74355     07/07/75  11.08.03.      PAGE    11

VARIABLES      SN  TYPE             RELOCATION
  1077  WTR2       REAL                  C              REFS      16       194
   650  W12        REAL                                 REFS     204    DEFINED     203
   703  XL         REAL       ARRAY                     REFS      74       177      178

FILE NAMES         MODE
       TAPE6       FMT                    WRITES     187      216

EXTERNALS          TYPE    ARGS        REFERENCES
       ATAND       REAL      2            153       154      172      173
       COSD        REAL      1            119       121
       FINTP1      REAL      5            177       178
       SIND        REAL      1            120       122

INLINE FUNCTIONS   TYPE    ARGS         DEF LINE  REFERENCES
       ABS         REAL      1  INTRIN            2*179      186      198      199      210      211    2*226    2*227
                                                    243      244      252      259    2*262      268      276    2*279
       AINT        REAL      1  INTRIN              115
       SIGN        REAL      2  INTRIN              198      199      243      244      253      259      260      269
                                                    276      277

STATEMENT LABELS              DEF LINE   REFERENCES
    10   1                       116       113
     0   2                       160       156
     0   3           INACTIVE    286
   114   5                       149       137
   301  20                       221       215
   314  21                       228       220
   214  30                       190       170      179      181
   136  32                       164       152
   371  70                       257       252
   423  73                       266       256
   440  80                       273       268
   475  83                       283       272
   566 100      FMT              217       216
   547 101      FMT              188       187

LOOPS  LABEL     INDEX      FROM-TO     LENGTH     PROPERTIES
   127  2          L        156 160      3B         INSTACK

COMMON BLOCKS    LENGTH     MEMBERS - BIAS NAME(LENGTH)
       C          3830             0 C       (3830)

EQUIV CLASSES    LENGTH     MEMBERS - BIAS NAME(LENGTH)
C      C          3830         370 RANGE   (1)           371 RXBA    (1)           372 RYBA    (1)
                               373 RZBA    (1)           402 WLAMQ   (1)           436 WLAMR   (1)
                               423 BTHTGD  (1)           426 BTHTG   (1)           427 BPSIGD  (1)
                               430 BPSIG   (1)           434 BEPSZ   (1)           435 BEPSY   (1)
                               479 GQ1     (1)           480 GR1     (1)           481 GQ2     (1)
                               482 GR2     (1)           483 GQ3     (1)           484 GR3     (1)
                               485 GQ4     (1)           486 GR4     (1)           488 GQ5     (1)
                               489 GR5     (1)           490 GQ6     (1)           491 GR6     (1)
                               492 DTHCQ   (1)           493 DTHCR   (1)           494 DTHRGQ  (1)
                               495 DTHRGR  (1)           496 GEOGG   (1)           499 DQ1     (1)
                               500 DR1     (1)           502 Q1      (1)           503 R1      (1)
                               505 DQ2     (1)           506 DR2     (1)           508 Q2      (1)
                               509 R2      (1)           511 DQ3     (1)           512 DR3     (1)
                               513 DWO     (1)           514 Q3      (1)           515 R3      (1)
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      SUBROUTINE S3          74/74    OPT=1                          FTN 4.2+74355        07/07/75  11.08.03.        PAGE    12

EQUIV CLASSES    LENGTH      MEMBERS - BIAS NAME(LENGTH)
                                 516 WO       (1)              519 OWI      (1)              522 WI       (1)
                                 525 BEPSYSV(1)                528 BEPSZSV(1)                544 KQ1      (1)
                                 545 KR1      (1)              546 KQ2      (1)              547 KR2      (1)
                                 548 KQ3      (1)              549 KR3      (1)              550 KQ5      (1)
                                 551 KR5      (1)              552 KQ6      (1)              553 KR6      (1)
                                 554 KQ7      (1)              555 KR7      (1)              556 KQ8      (1)
                                 557 KR8      (1)              558 KQ10     (1)              559 KR10     (1)
                                 560 KQ11     (1)              561 KR11     (1)              562 KQ12     (1)
                                 563 KR12     (1)              564 JI       (1)              565 JO       (1)
                                 566 FRI      (1)              567 FRO      (1)              568 TUI      (1)
                                 569 TUO      (1)              570 QERG     (1)              571 RERG     (1)
                                 572 WTQ1     (1)              573 WTR1     (1)              574 WTQ2     (1)
                                 575 WTR2     (1)              576 WGQ1     (1)              577 WGR1     (1)
                                 578 WGQ2     (1)              579 WGR2     (1)              580 WGQ3     (1)
                                 581 WGR3     (1)              582 WGQ4     (1)              583 WGR4     (1)
                                 584 WGQ5     (1)              585 WGR5     (1)              586 WGQ6     (1)
                                 587 WGR6     (1)              588 WRQ1     (1)              589 WRR1     (1)
                                 590 WRQ2     (1)              591 WRR2     (1)              592 WRQ3     (1)
                                 593 WRR3     (1)              594 WQ24     (1)              595 WRR4     (1)
                                 596 RCL      (1)              597 TCLQ     (1)              598 TCLR     (1)
                                 599 TAU      (1)              600 TARHT    (1)              601 TARHD    (1)
                                 602 RBLOCK   (1)              603 FFOV     (1)              604 IOCS     (1)
                                 605 TLAG     (1)              606 BRLKQ    (1)              607 TDELAY   (1)
                                 608 THTQ     (1)              609 THTR     (1)              610 KUO      (1)
                                 611 KUI      (1)              612 KBO      (1)              613 KBI      (1)
                                 614 KPO      (1)              615 KPI      (1)              616 KOAO     (1)
                                 617 KOAI     (1)              618 UCC      (1)              619 USC      (1)
                                 620 UCCG     (1)              621 USCG     (1)              624 IBL      (1)
                                 649 TIMESV   (6)              655 LOSZ     (6)              661 LOSY     (6)
                                1675 ANGX     (1)             1676 ANGY     (1)             1677 ANGZ     (1)
                                1735 WPO      (1)             1738 WP       (1)             1739 WQO      (1)
                                1742 WQ       (1)             1743 WRO      (1)             1746 WR       (1)
                                1750 CRAD     (1)             1999 TIME     (1)             2019 LCONV    (1)
                                3511 I3512    (1)             3633 ISNOX    (1)

STATISTICS
  PROGRAM LENGTH                7058      453
  CM LABELED COMMON LENGTH     73663     3830
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